HORIZONTAL DIRECTIONAL DRILL ANALYSIS
LETORT SPRING RUN CROSSING
PADEP SECTION 105 PERMIT NO. E21-449
PA-CU-0136.0002-WX-16
(SPLP HDD S2-0210-16)

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This reanalysis of the horizontal directional drill (HDD) installation of a 16-inch diameter pipeline that traverses under LeTort Spring Run in Middlesex Township, Cumberland County, Pennsylvania, is in accordance with the Stipulated Order issued under Environmental Hearing Board Docket No. 2017-009-L for HDDs listed on Exhibit 3 of the Stipulated Order. This HDD is number 8 on the list of HDDs included on Exhibit 3 of the Order.

PIPE INFORMATION

16-Inch: 0.438 wall thickness; X-70

Pipe stress allowances are an integral part of the design calculations performed for each HDD.

ORIGINAL HORIZONTAL DIRECTIONAL DRILL DESIGN SUMMARY: 16-INCH

- Horizontal length: 1,950 feet
- Entry/Exit angle: 16 degrees
- Maximum Depth of cover: 155 feet
- Pipe design radius: 2,000 feet

ROOT CAUSE ANALYSIS FOR THE 20-INCH PIPE INSTALLATION IR EVENTS

Based upon an analysis by the project geologists and drilling specialists, the occurrence of the five (5) IR events during the installation of the 20-inch pipe in May of 2017 at the LeTort Spring Run is likely to have been caused by the drilling contractor not maintaining a clean annulus, either by maintaining circulation to the entry pit, or tripping out the drilling tools to clean the pilot hole when circulation was lost. In summary, SPLP confirmed that a “closed and compacted annulus” was the root cause of the IRs to the land surface during the initial pilot hole attempt.

Restart approval was provided the Pennsylvania Department of Environmental Protection (PADEP) in April of 2018. During the second, and finally successful HDD of the 20-inch pipeline installation, nine (9) IRs or activation of prior IR locations occurred during the completion of the HDD.

The opinion of the drilling specialists is the occurrence of these IRs is likely due to the hydraulic fracturing of the bedrock above and below the original HDD profile resulting from the pilot hole attempt in 2017. Evidence to support this conclusion is the re-activation of prior IR locations, which despite the redesigned and deepened 20-inch profile, did not result in the drilling of a clean pilot hole in undisturbed geology.

GEOLOGIC AND HYDROGEOLOGIC ANALYSIS

HDD S2-0210 is located within the Great Valley Section, also known as the Cumberland Valley Section of the Ridge and Valley Physiographic Province (Pennsylvania Department of Conservation and Natural Resources [PA DCNR], 2000) underlain by very finely crystalline limestone with minor occurrences of dolomite and chert. Local topography is characterized by rolling valleys of low relief and natural slopes that are gentle and relatively stable. Geologic structures are characterized as thrust sheets, nappes, overturned folds and steeply inclined faults. Areas underlain by these rock units typically have good subsurface drainage and poor surface drainage where bedrock dissolution results in the development of bedrock pinnacles and solution cavities (e.g., sinkholes, voids, caves). Based on the United States Geological Survey (USGS) 7.5-Minute Carlisle

Topographic Quadrangle (refer to Figure 1), the site is situated at an approximate elevation of 425 feet above mean sea level (AMSL). Surface topography at the site slopes west and east along the HDD to LeTort Spring Run. The major surface water feature is LeTort Spring Run which flows northeast and then northwest to Conodoguinet Creek.

The proposed HDD bore path passes beneath LeTort Spring Run. The area surrounding the eastern HDD entry/exit point consists predominantly of an open agricultural land interspersed with suburban residential properties and bordered by the Pennsylvania Turnpike, South Middlesex Road, and Interstate 81. The area surrounding the western HDD entry/exit point consists of a wooded area surrounded by interspersed commercial properties and open agricultural lands at the intersection of the Pennsylvania Turnpike and the Harrisburg Pike.

A non-invasive geophysical survey was performed at HDD S2-0210 from October 16 through October 23, 2017. The purpose of the geophysical survey was to determine the depth to bedrock, overburden thickness, and identify areas of solid and fractured rock. Seismic refraction, multichannel analysis of surface waves (MASW), and electrical resistivity methods were used during the survey. A summary is provided below.

Results of the seismic refraction survey generally indicated a stratigraphy comprised of unconsolidated material and competent bedrock. The seismic data suggests a generally consistent inferred bedrock surface of approximately 20 feet bgs. The contoured seismic data represents an average seismic velocity profile indicating a gradational interface between the unconsolidated material and competent bedrock. Given these findings and interpretation of the collected field data, bedrock pinnacles common in the St. Paul Group may extend above or below the inferred contour between the unconsolidated material and bedrock.

The results of the MASW survey indicated a two-layer stratigraphy similar to the seismic results. However, the shallow depth to bedrock and bedrock pinnacles limited the dispersion of the signal source. This resulted in a low signal to noise ratio, and did not provide effective imaging resolution within the apparent bedrock and fractured bedrock zones.

The electrical imaging data indicated a depth to bedrock of 15 to 30 feet bgs. High-resistivity zones represent competent bedrock and low-resistivity zones represent weathered or fractured bedrock. Three low-resistivity zones were identified during the survey and may represent more permeable bedrock fracture zones that could provide potential pathways for fluid transport.

Attachment 1 provides an extensive discussion on the geology and results of the geotechnical investigation performed at this location, which informs this analysis.

HYDROGEOLOGY, GROUND WATER, AND WELL PRODUCTION ZONES

Bedrock geology ultimately influences the storage, transmission, and use of groundwater. Geologic factors such as rock type, intergranular porosity, rock strata inclination, faults, joints, bedding planes, and solution channels affect groundwater movement and availability. In general, groundwater generally occurs under unconfined conditions within the upper portion of the bedrock and under confined or semi-confined conditions in the deeper portions of the bedrock.

Groundwater at the site occurs in a fractured, solution-prone, carbonate bedrock aquifer system within the St. Paul Group. In carbonate rocks, water-bearing zones generally occur in solution-enhanced secondary openings that form along bedding planes, joints, faults and fractures. Most of the water-bearing zones penetrated by supply wells occur in individual fractures or groups of interconnected fractures that are sufficiently enlarged by dissolution for readily transporting groundwater.

The St. Paul Group is the uppermost rock unit near HDD S2-0210. Based upon Tetra Tech's geotechnical exploration activities completed in January of 2015, at Boring SB-01, located approximately 725 feet northeast of the HDD entry, groundwater was not encountered and auger refusal occurred at 15 feet below ground surface (bgs). At Boring SB-02, located approximately 30 feet southwest of the HDD exit, groundwater was encountered in at a depth of 11 feet bgs, and the completion depth was 28.2 feet bgs.

A more recent geotechnical report of exploration activities performed in June of 2017 included two (2) additional borings. Boring B-1, located approximately 100 feet southwest of the HDD exit, was completed to a total depth of 150.5 feet bgs with groundwater encountered at 9.0 feet bgs. Boring B-2, located approximately 100 feet northeast of the HDD entry, was completed to a total depth of 150.0 feet bgs with groundwater encountered at 16.3 feet bgs.

The average depth of water wells in the St. Paul Group is reported to be 384 feet with an average depth to water of 32 feet. Rocks of the St. Paul Group have a reported median sustained yield of 25 to 82 gallons/minute (gal/min) based on fracturing and solution openings. Sustained yields of large production wells are reportedly between 105 and 260 gal/min.

There are no known public or private water supply wells within 450 feet of the HDD profile.

Attachment 1 provides an extensive discussion on the hydrogeology which informs this analysis.

ADJACENT FEATURES ANALYSIS

This HDD location is 0.5 miles southwest of Middlesex Township in Cumberland County, Pennsylvania. The pipeline alignment crosses under LeTort Spring Run for 0.24 miles east of the intersection of the Pennsylvania Turnpike and Harrisburg Pike to a location 0.18 miles west-northwest of the intersection of Interstate Highway 81 and the Pennsylvania Turnpike.

This HDD location is set under LeTort Spring Run (stream S-I48). The HDD also traverses beneath forested lands, agricultural lands, two ephemeral streams (S-I49 and S-I50), emergent wetland W-I31, and forested wetland W-I32. Streams S-I48, S-I49 and S-I50 both have a Chapter 93 Existing Use designation as High Quality-Cold Water Fisheries. Wetlands I31 and I32 are Exceptional Value wetlands.

There are no recorded public or private water supply wells within 450 feet of the HDD profile; however, subsequent to the 2018 Administrative Order, SPLP identified all landowners with property located within 450 feet of the HDD alignment and provided these landowners with a notice letter via both certified and first-class mail that included an offer to sample the landowner's private water supply/well in accordance with the terms of the Order and the Water Supply Assessment, Preparedness, Prevention and Contingency Plan. The letter also requested that each landowner contact the Right-of-Way agent for the local area and provide SPLP with information regarding: (1) whether the landowner has a well; (2) where that well is located, and its depth and size if known; and (3) whether the landowner would like to have the well sampled. In accordance with paragraph 10 of the Order, copies of the certified mail receipts for the letters sent to landowners have been provided to Karyn Yordy, Executive Assistant, Office of Programs at the Department's Central Office.

As a result of these communications with the landowners within 450 ft of the HDD profile, SPLP has verified that no private water supply wells exist within the specific HDD buffer area

To further avoid and mitigate any adverse effects from the HDD, and in accordance with the requirements of the Stipulated Order, SPLP will transmit a copy of this HDD analysis to all landowners having a property line within 450 feet of any direction of this HDD location.

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ALTERNATIVES ANALYSIS

As required by the Order, the reevaluation of HDD S2-0210 includes an analysis of open cut alternatives and potential re-routes. As part of the PADEP Chapter 105 permit process for the Mariner II East Project, SPLP developed and submitted for review a project-wide Alternatives Analysis. During the development and siting of the Project, SPLP considered several different routings, locations, and designs to determine whether there was a practicable alternative to the proposed impact. SPLP performed this determination through a sequential review of routes and design techniques, which concluded with an alternative that has the least environmental impacts, taking into consideration cost, existing technology, and logistics. The baseline route provided for the pipeline construction was to cross every wetland and stream on the project by open cut construction procedures. The Alternatives Analysis submitted to PADEP conceptually analyzed the potential feasibility of any alternative to baseline route trenched resource crossings (e.g., reroute, conventional bore, HDD). The decision-making processes for selection of the HDD instead of an open cut crossing methodology is discussed thoroughly in the submitted alternatives analysis and was an important part of the overall PADEP approval of HDD plans as currently permitted. As described below, the open cut and re-route analyses have confirmed the conclusions reached in the previously submitted Alternatives Analysis.

Open-cut and Conventional Bore Analysis

Conversion to an open cut trenched crossing method would result in direct but temporary impacts to the floodway and bed and banks of LeTort Spring Run (stream S-I48) which is designated as HQ-CWF, direct but temporary impacts to the floodways of HQ-CWF streams I49 and I50, EV wetland W-I31 (palustrine emergent wetland), and EV wetland W-I32 (palustrine forested wetland) SPLP specifications require a minimum of 48 inches of cover between the installed pipeline and the bottom of the watercourse. To meet this cover requirement, during trenched construction through this area, a workspace with a width up to 75 feet would be required to accommodate the pipelines and provide sufficient space for trench excavation, spoil storage, and sufficient separation between pipelines (for integrity management). The assessed area of impact by this open cut plan would directly affect approximately 61 feet at the LeTort Spring Run crossing (stream S-I48), with 71 feet of forested wetland (wetland W-I32) adjacent to the west bank, and 156 feet of emergent wetland (wetland W-I31) adjacent to the east bank. The assessed area of impact by this open-cut plan would directly affect 0.4 acres of state water bottom, 0.19 acre of emergent wetland, and 0.14 acre forested wetland

As mentioned above, converting to an open cut trenched crossing method through this area would result in impacts to exceptional value wetland W-I31 and W-I32, including approximately 0.19 acre and 0.14 acre of impacts to emergent and forested wetland vegetative cover types, respectively. The HDD will largely avoid surface impacts to biological features and as currently proposed, results in no surface impacts to wetlands (impact avoidance) compared to the open cut alternative.

Open cut impacts to these resources would require modification of the state and federal permits. Moreover, any produced groundwater in the open excavations would be pumped to a discharge filtration structure. The current feasible filtration ability, however, does not exceed 50 microns. Therefore, cloudy water (from suspended fine clay and silt particles) would be discharged downstream regardless of all control methods employed for the entire duration of the use of open cut construction techniques.

Finally, conventional auger bore is technically limited to less than 200 linear feet at a time varying by the underlying substrate. Due to the spacing constraints at the location of this HDD, there are no subset locations within this length of area to feasibly employ this type of installation method.

SPLP also analyzed the option to employ a direct pipe bore for the crossing of LeTort Spring Run. Although there is sufficient workspace outside of wetlands to feasibly establish an entry rig setup, the variability in the near subsurface geology was determined to likely result in drifting off alignment of this type of boring unit which would ultimately result in the geologic binding of the rock against the pipe casing and result in a failed bore attempt.

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Re-Route Analysis

Due the general route of the Mariner II Project in this area of the state is from west to east, and general north-south direction of LeTort Spring Run, no practicable re-route option lies to the north or south of the proposed route that would not ultimately transect this stream. The geology across the broader area, miles in extent, is karst; therefore, no reasonable re-route is available that would alter the subsurface geologic conditions. The pipeline route as currently permitted follows an existing SPLP easement and bypasses or avoids directly impacting forested and emergent wetlands, forested land, and LeTort Spring Run.

Shifting the north or south would result in new "greenfield" corridor through existing woodlands along the LeTort Spring Run and would still require a crossing of LeTort Spring Run. The shift north would be into a high density commercial and residential area prior to it adjoining with an existing utility corridor. The shift south would significantly increase woodland impacts and require crossing the Pennsylvania Turnpike twice.

In summary, due to the location of LeTort Spring Run, woodlands adjacent to it, and the presence of commercial and residential properties, there is no alternative route that could avoid conflicts with existing development and existing woodland buffers to LeTort Spring Run.

This re-route analysis conducted for the LeTort Spring Run HDD confirms the conclusions reached in the previously submitted alternatives analysis.

REDESIGNED HORIZONTAL DIRECTIONAL DRILL DESIGN SUMMARY: 16-INCH

- Horizontal length: 1,950 feet
- Entry/Exit angle: 16 degrees
- Maximum Depth of cover: 144 feet
- Pipe design radius: 2,000 feet

CONCLUSION

The 16-inch HDD profile has been re-designed to allow for a deeper crossing beneath LeTort Spring Run than was completed for the 20-inch pipeline installation. The inclination of the entry and exit angles has been increased in order to install the 16-inch pipe through protective soils, residual soils, and bedrock in closer proximity to the entry and exit points than the original shallower profile. From a geologic perspective, the deeper profile, in conjunction with the proposed engineering controls and/or drilling best management practices, will be used to reduce the risk of an IR. Attachment 2 presents view of the initial 2017 16-inch HDD Plan and Profile with the 20-inch "as built" profile and IR locations, as well as a redesigned 16-inch HDD Plan and Profile post installation of the 20-inch pipeline.

Upon the start of this HDD, SPLP will employ the following HDD best management practices:

- SPLP will provide the drilling crew and company inspectors (UI, EI, PGs) the location(s) data on potential zones of higher risk for fluid loss and IRs, including the area related to previous IRs, and potential zones of fracture concentration identified by the fracture trace analysis along the drill path, so that monitoring can be enhanced when drilling through these locations;

- SPLP will mandate annular pressure monitoring (APM) during the drilling of the pilot hole, which assists in immediate identification of pressure changes indicative of loss of circulation (LOC) or over pressurization of the annulus, managing development pressures that can induce an IR;

- SPLP's drilling contractor will utilize the drilling and monitoring log data for the 20-inch HDD as guidance on approaching the potential zone where drilling fluids were lost during the 20-inch HDD, such that corrective action by injection of Loss Control Materials (LCMs), or grouting can be implemented if the APM or return of drilling fluids indicate a loss in the same general area of the profile, or elsewhere;

- SPLP inspectors will ensure that an appropriate diameter pilot tool, relative to the diameter of the drilling pipe, is used to ensure adequate "annulus spacing" around the drilling pipe exits to allow good return flows during the pilot drilling;

- SPLP will mandate short-tripping of the reaming tools to ensure an open annulus is maintained to manage the potential inducement of IRs;

- SPLP will implement short-tripping of the reaming tools as return flow monitoring indicates to ensure an open annulus is maintained to manage the potential inducement of IRs;

- SPLP will require monitoring of the drilling fluid viscosity, such that fissures and fractures in the subsurface are sealed during the drilling process;

- During all drilling phases, the use of Loss Control Materials (LCMs) will be considered if indications of a potential IR are noted or an IR is observed. The use of LCMs, however, is less effective below 70 ft of the ground surface. The AP below that depth can exceed the effective stabilization capability of LCMs. Accordingly, the preferred proactive corrective action needed to address the presence of fractures or unstable geology at greater depths below ground may require grouting of the HDD annulus. Two types of grouting will be utilized for corrective actions to seal fractures and stabilize zones of weak geology. These are: 1) grouting using "neat cement"; and 2) grouting using a sand/cement mix. Neat cement grout is a slurry of Portland cement and water. The sand/cement grout mix is a slurry of mostly sand with a small percentage of Portland cement and activators that after setup results in a material having the competency of a friable sandstone or mortar. Both grouting actions require tripping out the drilling tool, and then tripping in with an open-ended drill stem to apply or inject the grout mixes. Either of these grouting actions will be implement upon the first detection of an LOC with the selection of the treatment based upon the circumstances of the LOC, being small or large in magnitude indicative or a minor or major fracture.

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FEASIBILITY DETERMINATION

Based on the information reviewed by the Geotechncial Evaluation Leader, Professional Geologists, Professional Engineers, and HDD specialists, the HDD Reevaluation Team's opinion is that the proposed HDD design and implementation of the management measures contained within this re-revaluation report will minimize the risk of IRs and impacts to public and private water supplies during the construction phases of the HDD.

Pertaining to Horizontal Directional Drilling Practices and Procedures; Conventional Construction; Alternatives; and Environmental Effects

2/1/2019
Date

Larry J. Gremminger, CWB
Geotechnical Evaluation Leader
Mariner East 2 Pipeline Project

Pertaining to the practice of geology

2/1/19
Date

Douglas J. Hess, P.G.
License No. PG-000186-G
Skelly and Loy, Inc.
Director of Groundwater
and Site Characterization
Geo-Environmental Services

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
DOUGLAS JAY HESS
GEOLOGIST
NO. PG000186G

Pertaining to the pipeline stress and HDD geometry

2/1/19
Date

Jeffery A. Lowy, P.E.
Lic. No. PE082759
Rooney Engineering, Inc.
Civil Engineer

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
JEFFREY A. LOWY
ENGINEER
PE082759
2/1/19

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ATTACHMENT 1

GEOLOGY AND HYDROGEOLOGICAL EVALUATION REPORT

RETTEW

We answer to you.

3020 Columbia Avenue, Lancaster, PA 17603 ● Phone: (800) 738-8395
E-mail: rettew@rettew.com ● Website: rettew.com

Engineers
Environmental Consultants
Surveyors
Landscape Architects
Safety Consultants

January 30, 2019

Mr. Matthew Gordon
Sunoco Pipeline, L.P.
535 Fritztown Road
Sinking Spring, PA 19608

RE: Sunoco Pipeline, L.P. Pipeline Project-Mariner East II
LeTort Spring Run HDD S2-0210
PA-CU-0136.0002-WX-16
Hydrogeologic Re-Evaluation Report for 16-Inch Pipeline
Middlesex Township, Cumberland County, PA
RETTEW Project No. 096302011

EXECUTIVE SUMMARY

1. The Corrected Stipulated Order Dated August 10, 2017 requires a re-evaluation of the proposed 16-inch drill at the LeTort Spring Run horizontal directional drill (HDD) location S2-0210.
2. The site is underlain by finely crystalline limestone and dolomite of the St. Paul Group (Osp) which is typically characterized by good subsurface drainage; however areas of poor surface drainage exist where bedrock pinnacles and sinkhole development occur.
3. Water-bearing zones in the underlying geology generally occur in secondary openings along bedding planes, joints, faults, and fractures. The permeability of these features is enhanced by dissolution of the limestone and dolomite bedrock.
4. The average depth of water supply wells in the St. Paul Group is 384 feet below ground surface (bgs) with an average depth to water of 32 bgs. Water-bearing zones are abundant at shallow depths and typically extend to depths of approximately 250 feet bgs.
5. The HDD profile for the proposed 16-inch drill has been redesigned to increase its depth beneath the streams and wetlands.
6. Based on the hydro-structural characteristics of the underlying geology and occurrence of inadvertent returns (IRs) during the installation of the 20-inch pipe, the LeTort Spring Run HDD is susceptible to an IR of drilling fluids during HDD operations for the planned 16-inch drill. The redesigned 16-inch HDD profile and HDD best management practices during drilling operations will be used to reduce the risk of an IR.

1.0 INTRODUCTION

The purpose of this report is to describe the geologic and hydrogeologic setting of the LeTort Spring Run S2-0210 HDD location on the Sunoco Pipeline, L.P. (SPLP) Pennsylvania Pipeline Project-Mariner II East (PPP-ME2) Project. The LeTort Spring Run HDD is located in Middlesex Township, Cumberland County, Pennsylvania as shown on **Figure 1**. The HDD is located between the north side of Pennsylvania Interstate 76 and the Love's Travel Stop, and was designed to be drilled under LeTort Spring Run (S-I148), two small

streams (S-I149 and S-I150) and two wetlands (W-131 and W-132) as shown on **Figure 1**. This re-evaluation report is part of the response to the Corrected Stipulated Order dated August 10, 2017 related to the IR of drilling fluids that occurred on May 10 and May 19, 2017, and numerous subsequent IRs, during HDD operations for the 20-inch pipe, that was completed on September 25, 2018.

The 16-inch HDD profile was redesigned on December 11, 2018 to increase the depth of the HDD bore path crossing beneath the streams and wetlands. The redesigned west HDD entry/exit is at a surface elevation of approximately 436 feet above mean sea level (AMSL) and the redesigned east HDD entry/exit is at a surface elevation of approximately 428 feet AMSL. The HDD profile was extended to the east resulting in a total bore path/pipe length of 1,950 feet. The extended profile allows for deepening of the profile to approximately 115 feet below LeTort Spring Run (this is approximately 17 feet deeper than the 20-inch pipe). The existing 20-inch and proposed 16-inch S2-0210 HDD locations are shown on Figure 1 and the redesigned 16-inch profile is included as **Attachment 1.**

2.0 GEOLOGY AND SOILS

Based upon publications by the Pennsylvania Bureau of Topographic and Geologic Survey (PABTGS), the site is in the Great Valley Section of the Ridge and Valley Physiographic Province of Pennsylvania, and is underlain by very finely crystalline limestone with minor occurrences of dolomite and chert (Sevon, 2000). Local topography is characterized by rolling valleys of low relief and natural slopes that are gentle and relatively stable. Geologic structures are characterized as thrust sheets, nappes, overturned folds and steeply inclined faults. Areas underlain by these rock units typically have good subsurface drainage and poor surface drainage where bedrock dissolution results in the development of bedrock pinnacles and solution cavities (e.g., sinkholes, voids, caves). Based on the United States Geological Survey (USGS) 7.5-Minute Carlisle Topographic Quadrangle Map shown on **Figure 1**, the site is situated at an approximate elevation of 425 feet AMSL. Surface topography at the site slopes west and east along the HDD toward LeTort Spring Run. The major surface water feature is LeTort Spring Run which flows northeast and then northwest before discharging to Conodoguinet Creek.

The site geology is mapped as the St. Paul Group (Osp) as shown on **Figure 2** (Socolow, 1980). This geologic Group is described as buff-colored, finely crystalline magnesium limestone containing numerous layers of chert, high calcium limestone in part, and is approximately 900 feet in thickness (Root, 1978). The lower and upper parts of the Group are predominantly pure limestone except for minor amounts of dolomite. The middle part consists of darker, impure limestone and abundant interbanded dolomite and some dolomite interbeds. This Group is well bedded, fissile to flaggy in nature, and contains some thick-bedded sections. Most joints have a blocky pattern, with some having a platy pattern; but are moderately well developed, moderately to highly abundant and fairly to regularly spaced. There is a moderate distance between fractures, most fractures are open, and some are filled with calcite. Fractures are usually steeply dipping to vertical. This Group is moderately resistant to weathering and is slightly weathered to shallow depths; resulting in medium-sized blocks. The overlying mantle is moderately thick and in most places the bedrock-mantle interface is characterized by bedrock pinnacles. This Group is considered difficult to excavate due to the degree and extent of bedrock pinnacle development. Foundation stability is good, provided the excavation extends to sound bedrock and solution cavities are thoroughly investigated and mitigated. Subsurface drainage is good and is characterized by the development of sinkholes at the surface and caves at depth. Secondary porosity is provided by interconnections between joint and solution channel openings, and is moderate to high in magnitude; permeability of the Group is generally high (Geyer and Wilshusen, 1982).

According to the United States Department of Agriculture (USDA) Soil Survey of Cumberland County, Pennsylvania, soils within the vicinity of the LeTort Spring Run HDD consist of seven distinct soil units. A USDA map that depicts the mapped area, along with the soil profile descriptions, is included as **Attachment 2**.

3.0 HYDROGEOLOGY

Groundwater at the site occurs in a fractured, solution-prone, carbonate bedrock aquifer system within the St. Paul Group. In carbonate rocks, water-bearing zones generally occur in solution-enhanced secondary openings that form along bedding planes, joints, faults and fractures. Most of the water-bearing zones penetrated by supply wells occur in individual fractures or groups of interconnected fractures that are sufficiently enlarged by dissolution to provide pathways for the transport of groundwater.

The average depth of water supply wells in the St. Paul Group is reported to be 384 feet bgs with an average depth to water of 32 feet bgs. Rocks of the St. Paul Group have a reported median sustained yield of 82 gallons per minute (gpm) attributed to well-developed fractures and solution openings. Sustained yields of large capacity production wells are reportedly between 105 and 260 gpm. Although the maximum density of water-bearing zones is developed at shallow depths, these zones are nearly as abundant to depths of 250 feet bgs. Between 251 and 550 feet, water yielding zones are rare. However, in the 551- to 600-foot depth bgs range, the number of zones per 100 feet of hole evaluated is almost as great as in the shallower zone (Becher and Root, 1981).

Well records for 37 individual water supply wells within a 0.5-mile radius of the LeTort Spring Run HDD were obtained from the Pennsylvania Groundwater Information System (PaGWIS). The information obtained from these well records is summarized in the following table:

Well No.	Well Use	Casing Depth (feet)	Total Depth (feet)	Water Level (feet)	Yield (gpm)
97180	Domestic	34	173	24	15
97179	Domestic/Stock	43	348	35	10
97161	Domestic	80	140	52	18
97050	Domestic	126	375	22	9
97025	Domestic	101	296	8	50
97016	Domestic	70	465	35	12
97001	Domestic	42	120	25	5
96999	Domestic	102	125	Unknown	30
669948	Domestic	63	142	Unknown	12
669927	Domestic	40	400	300	1
669926	Domestic	31	150	Unknown	Unknown
669925	Domestic	40	100	40	1
669924	Domestic	20	300	Unknown	Unknown
561806	Domestic	35	50	Unknown	2
561354	Domestic	Unknown	Unknown	Unknown	Unknown
561348	Domestic	Unknown	Unknown	Unknown	Unknown
561341	Domestic	Unknown	Unknown	Unknown	Unknown

Well No.	Well Use	Casing Depth (feet)	Total Depth (feet)	Water Level (feet)	Yield (gpm)
561340	Domestic	Unknown	Unknown	Unknown	Unknown
561339	Domestic	Unknown	Unknown	Unknown	Unknown
561338	Domestic	Unknown	Unknown	Unknown	Unknown
561337	Domestic	Unknown	Unknown	Unknown	Unknown
561336	Domestic	Unknown	Unknown	Unknown	Unknown
561335	Domestic	Unknown	Unknown	Unknown	Unknown
561334	Domestic	Unknown	Unknown	Unknown	Unknown
561332	Domestic	Unknown	Unknown	Unknown	Unknown
561331	Domestic	Unknown	Unknown	Unknown	Unknown
561330	Domestic	Unknown	Unknown	Unknown	Unknown
561313	Domestic	Unknown	Unknown	Unknown	Unknown
561312	Domestic	Unknown	Unknown	Unknown	Unknown
561310	Domestic	Unknown	Unknown	Unknown	Unknown
561309	Domestic	Unknown	Unknown	Unknown	Unknown
561291	Domestic	Unknown	Unknown	Unknown	Unknown
561290	Domestic	Unknown	Unknown	Unknown	Unknown
561254	Domestic	Unknown	Unknown	Unknown	Unknown
324590	Domestic	84	140	40	30
320749	Domestic	84	405	Unknown	20
320736	Domestic	60	550	Unknown	3

As a condition of the corrected Stipulated Order, other Sunoco subcontractors researched private water supplies located within a 450-foot radius of the LeTort Spring Run HDD. No private wells were identified within the 450-foot radius. However, two supply wells were identified approximately 1,016 and 1,303 feet northeast of the proposed 16-inch HDD profile as shown on **Attachment 3.**

4.0 FRACTURE TRACE ANALYSIS

Fracture traces underlying, or in close proximity to the LeTort Spring Run HDD, were evaluated using historical aerial photographs from the years 1994 through 2016 (Google Earth, 2017), the Carlisle, PA USGS 7.5-Minute Topographic Quadrangle Map, and the Geologic Map of the Carlisle and Mechanicsburg Quadrangles, Cumberland County, Pennsylvania (Root, 1978). The aerial photographs and maps were used to approximate locations of natural linear features or lineaments expressed on the ground surface. The linear features may be the surficial representation of deeper fractures, joints, faults or bedding planes within the subsurface which can transmit groundwater through the fractured bedrock aquifer underlying the LeTort Spring Run HDD.

Figures 2 and **3** show the results of the fracture trace analysis overlain on the geologic map and aerial base map, respectively. Twelve fracture traces were identified in close proximity to the proposed LeTort Spring Run HDD. Four of the fracture traces trend approximately northwest-southeast, parallel to geologic strike. Eight of the fracture traces trend approximately northeast-southwest and may represent joint sets perpendicular to geologic strike. Nine of the fracture traces correspond with straight stream segments of LeTort Spring Run, and are likely associated with local geologic structure.

5.0 GEOTECHNICAL EVALUATION

Two geotechnical drilling investigations were performed at the site. The initial investigation was performed in January 2015 during the preliminary investigation of the LeTort Spring Run HDD and prior to initiating the 20-inch HDD operations. A second phase of geotechnical drilling was performed in June 2017. The 2015 test borings were advanced by hollow-stem auger drilling and NQ-sized wireline rock coring methods. These borings are designated as SB-01 and SB-02. The second phase test borings completed in 2017 were advanced using mud-rotary drilling and NQ-sized wireline rock coring methods. Soil, residual soil and weathered bedrock were sampled using split-spoon samplers. These borings are designated as B-1 and B-2. Geotechnical boring logs are included in **Attachment 1**.

Boring SB-01 was located approximately 725 feet northeast of the HDD entry. Boring SB-02 was located approximately 30 feet southwest of the HDD exit. Boring B-1 was located approximately 100 feet southwest of the HDD exit and Boring B-2 was placed approximately 100 feet northeast of the HDD entry. The locations of these borings are identified on **Figures 2** and **3.**

The generalized subsurface profile at the site, as observed in the borings, is described as follows:

- Soil and residual soils vary from boring to boring; 15.0 feet at SB-01, 28.4 feet at SB-02, 7.5 feet at B-1, and 6.25 feet at B-2. Residual soils are described as follows:
  - **Boring SB-01**: SILT (ML), elastic SILT (MH) and some weathered limestone from the ground surface to 15 feet bgs. Auger refusal was encountered at 15 feet bgs. Groundwater was not encountered in this boring.
  - **Boring SB-02**: Elastic SILT (MH) with trace to some fine sand, trace fine rock fragments and limestone. The boring was completed to 30.0 feet bgs. Groundwater was encountered at 11.0 feet bgs.
  - **Boring B-1**: Lean CLAY (CL) from the ground surface to 3.5 feet bgs. A bedrock pinnacle was encountered and the split-spoon sampler was replaced with the coring equipment. Coring methods were used to advance the boring through the residuum to a depth of 7.5 feet bgs where bedrock was encountered.
  - **Boring B-2**: Lean CLAY (CL) with a trace of sand was encountered from the ground surface to two feet bgs. A rollerbit was used to advance the boring to refusal at 4.5 feet bgs. Bedrock was encountered at 6.25 feet bgs.
- From the initiation of coring operations to the total depth of the NQ cores, weathered bedrock and bedrock were encountered and are described as follows:
  - **Boring SB-01**: Rock coring was not completed at this location.
  - **Boring SB-02**: Rock coring was not completed at this location.
  - **Boring B-1**: B-1 was completed to a total depth of 150.5 feet bgs. From 7.5 to 124.0 feet bgs a light gray to black, very fine-grained, slightly to highly weathered dolomite was observed. Joints range from horizontal to nearly vertical with some quartz infilling. Three zones of highly weathered fractures with clay development were observed at 1) 10.7 to 11.9, 2) 15, and 3) 84.5 to 85 feet bgs. Within the dolomite, rock recoveries were poor to excellent (45% to 100%) and rock quality designations (RQDs) were poor to excellent (28% to 100%). From 124.0 feet bgs to the completion depth of 150.5 feet bgs, a light gray to gray limestone was encountered. The limestone was very fine-grained to fine-grained and slightly weathered. Joints range from horizontal to nearly vertical and weathered with some quartz infilling. Rock recoveries in the

limestone were excellent (99% to 100%) and RQDs were fair to excellent (72% to 100%). Groundwater was encountered after coring operations at nine feet bgs.

- **Boring B-2:** B-2 was completed to a total depth of 150.0 feet bgs. From 6.25 feet to the completion depth of 150.0 feet bgs, a very fine to fine-grained dolomite was observed. The color of the dolomite varied from light gray to dark gray with some light gray to brown and light blue-gray observed in minor intervals. The dolomite was slightly to highly weathered. Joints range from horizontal to vertical with some quartz infilling and one small (0.25-inch) fracture with signs of clay development at 70.0 feet bgs. Recoveries were fair to excellent (74% to 100%) and RQDs were very poor to excellent (0% to 100%). Groundwater was encountered after coring operations at 16.3 feet bgs.

Unconfined compressive strength testing was performed on core samples, and the results are summarized in the table below.

Boring	Sample Depth (feet bgs)	Compressive Strength (psi)
B-1	10-14	16,828
B-1	38-43	12,282
B-1	57-62	17,486
B-1	77-82	13,012
B-1	92-97	16,282
B-1	112-116	14,709
B-1	132-137	15,160
B-1	147-150	14,256
B-2	13-18	8,520
B-2	40-45	8,498
B-2	55-60	10,102
B-2	80-85	12,761
B-2	95-100	15,883
B-2	110-115	13,163
B-2	120-125	11,874

Please note that Skelly and Loy and RETTEW did not oversee or direct the geotechnical drilling program associated with HDD S2-0210 including but not limited to, the selection of boring locations and target depths, observations of rock cores during drilling operations, or preparation of boring logs. The geotechnical reports, boring logs, and core photographs that resulted from these programs were generated by other Sunoco Pipeline, L.P. contractors. Skelly and Loy and RETTEW relied on these reports and incorporated the data into the general geologic and hydrogeologic framework included in this report.

6.0 GEOPHYSICAL SURVEY

A non-invasive geophysical survey was performed at HDD S2-0210 from October 16 through October 23, 2017. The purpose of the geophysical survey was to determine the depth to bedrock, overburden thickness, and identify areas of solid and fractured rock. Seismic refraction, multichannel analysis of surface waves (MASW), and electrical resistivity methods were used during the survey. A summary is provided below.

Results of the seismic refraction survey generally indicated a stratigraphy comprised of unconsolidated material and competent bedrock. The seismic data suggests a generally consistent inferred bedrock surface of approximately 20 feet bgs. It should be noted that the contoured seismic data represents an average seismic velocity profile indicating a gradational interface between the unconsolidated material and competent bedrock. Given these findings and our interpretation of the collected field data, bedrock pinnacles common in the St. Paul Group may extend above or below the inferred contour between the unconsolidated material and bedrock.

The results of the MASW survey indicated a two-layer stratigraphy similar to the seismic results. However, the shallow depth to bedrock and bedrock pinnacles limited the dispersion of the signal source. This resulted in a low signal to noise ratio, and did not provide effective imaging resolution within the apparent bedrock and fractured bedrock zones.

The electrical imaging data indicated a depth to bedrock of 15 to 30 feet bgs. High-resistivity zones represent competent bedrock and low-resistivity zones represent weathered or fractured bedrock. Three low-resistivity zones were identified during the survey and may represent more permeable bedrock fracture zones that could provide potential pathways for fluid transport.

7.0 FIELD OBSERVATIONS

A. DECEMBER 29, 2017 FIELD INVESTIGATION

A field investigation was performed by RETTEW staff on December 29, 2017 to identify rock outcrops for fracture fabric analysis, evaluation and ground-truthing of the topographic expression of fracture traces identified during the desktop exercise, and to identify additional potential sensitive receptors to IRs. Readily accessible bedrock outcrops in the vicinity of the LeTort Spring Run HDD were not identified during the reconnaissance. Nine of the 12 fracture traces are coincident with linear stream segments of LeTort Spring Run. Three additional fracture traces exhibit similar topographic expression on the ground surface; however, these features do not correspond with the proximate stream segments of LeTort Spring Run. These fracture traces likely represent perpendicular joint sets and suggest that some sections of LeTort Spring Run are locally controlled by geologic structure. No additional sensitive receptors were identified.

B. FIELD OBSERVATIONS DURING 20-INCH HDD ACTIVITIES

Multiple IRs occurred during the installation of the 20-inch pipe using HDD methods. The first IR occurred on April 20, 2017 and subsequent IRs resulted in the Consent Order and Agreement referenced in this report. Details regarding any of the IRs of drilling fluids that occurred can be found in the HDD Daily Reports submitted to SPLP and/or the Pennsylvania Department of Environmental Protection (PA DEP). Since restart approval was granted by the PA DEP in April 2018, a summary and discussion of drilling

activity and other events that occurred during the 20-inch HDD pipeline installation (drilling from the east to the west) initiated on April 12, 2018 and completed on September 25, 2018 is provided below.

- **April 12, 2018:** Pretec initiated pilot drilling from east to west after PA DEP approval was granted to restart HDD operations at the site.
- **April 13, 2018:** Groundwater surfaced approximately 180 feet from the east entry point with the pilot bit at approximately 168 feet from the east entry point. An IR was reported per the HDD Inadvertent Return Assessment, Preparedness, Prevention and Contingency Plan (IR PPC Plan) Section 5.1.6.
- **April 26, 2018:** Pretec resumed pilot drilling following PA DEP restart approval.
- **May 8, 2018:** SPLP voluntarily shut down east side drilling due to previous voluntary shutdown of west side drilling.
- **May 10, 2018:** Pretec resumed drilling after a revised drilling plan was submitted to SPLP which included details for casing installation methods and introduction of Loss Control Materials (LCMs).
- **May 15, 2018:** IR reoccurred at the April 13, 2018 location. Pretec excavated and constructed a containment pit around the IR location to contain and pump drilling fluids back to the reclaimer. HDD operations were voluntarily shut down by SPLP for further evaluation.
- **May 16, 2018:** HDD activities were restarted. Pretec began installing protective 30-inch, 16-inch, and 12-inch diameter telescoped casing to increase borehole integrity and reduce the risk of IRs.
- **May 22, 2018:** PA DEP approved a minor modification to ESG0300015002 which discussed the use of existing containment best management practices ("Containment BMPs") that were previously placed around previous IR locations encountered during the 2017 HDD operations. In its May 22, 2018 approval of the minor Chapter 102/105 permit modifications, the PA DEP required that SPLP submit a written request for approval to utilize the Containment BMPs for continuous control of HDD operations at the site (this written request was included in the Hydrogeologic Re-Evaluation Report submitted by SPLP to the PA DEP on June 1, 2018).
- **June 1, 2018:** SPLP submitted a revised Hydrogeologic Re-Evaluation Report to the PA DEP requesting restart approval of HDD operations and approval of the use of the Containment BMPs specified in the PA DEP's May 22, 2018 Chapter 102/105 permit modifications approval.
- **June 5, 2018:** PA DEP approved both SPLP's request to restart HDD operations and SPLP's specifications for the installation of Containment BMPs to address the April 25, 2017 IRs (located on the west side of the HDD profile) and the May 15, 2018 IR (located on the east side of the HDD profile).
- **June 9, 2018:** Pretec implemented Containment BMPs specified in the June 1, 2018 Hydrogeologic Re-Evaluation Report. Pretec resumed HDD operations on the east side and removed both the 16-inch and 24-inch diameter protective casing from the borehole, leaving approximately 40 feet of 30-inch diameter protective surface casing at the east entry point. Pretec initiated reaming from east to west using a 22-inch diameter reaming bit.
- **June 13, 2018:** After reaming to 168 feet from the east entry point the reamer stopped advancing. Pretec pulled the rods, but the reamer bit, sub and pilot rod were stuck in the borehole.
- **June 14, 2018:** Pretec installed 16-inch diameter protective casing to a point 175 feet from the east entry point (this casing was removed on June 16, 2018). PA DEP also granted approval to SPLP to operate two HDD rigs independently from opposing ends of the HDD bore path, as requested by SPLP in the June 1, 2018 Hydrogeologic Re-Evaluation Report. This approval was granted until such time that the HDD rigs were hydraulically communicating.

- **June 15-20, 2018:** Pretec attempted unsuccessfully to retrieve the bit, sub, and pilot rod from the borehole.
- **June 24, 2018:** Part of a fishing tool was lost downhole when the drill string was pulled by American Augers DD-10 rig. Pretec replaced American Augers DD-10 rig with a UNI 250x400 rig. One unsuccessful fishing attempt was made with the UNI 250x400 rig before abandoning the borehole.
- **June 25, 2018:** Pretec began drilling a new offset borehole 5 feet south of the abandoned borehole (east side of HDD).
- **June 27, 2018:** The IR Containment BMP was reactivated during the new offset borehole drilling when the bit was 186 feet from the east entry point. Pretec began pumping drilling fluid back to the east entry pit where it was recirculated during pilot bit advancement.
- **July 7, 2018:** HDD operations from the east side were shut down due to an IR of less than one gallon that was observed within the former IR containment area (from 2017) located closest to the west bank of LeTort Spring Run. At the time of this IR, the pilot bit was 650 feet from the east entry point. HDD operations were shut down pending PA DEP restart approval.
- **July 20, 2018:** PA DEP grants SPLP approval to restart HDD operations.
- **July 21, 2018:** Pretec injects a 1,000-gallon LCM pill containing bentonite, MAGMA Fiber and AMC Plug into the east side bore.
- **July 22, 2018:** Pretec resumes east- and west-side pilot drilling.
- **July 25, 2018:** Pretec ceases east-side drilling so Precision can perform hydrostatic testing on pipe segment from LeTort (east side) to Appalachian Drive (east side). During pilot drilling from the west side only, two previous IRs were reactivated – one within a permitted IR Containment BMP (where the 4/25/17, 5/1/18 and 5/5/18 IRs occurred in quantities of less than five gallons), and one at the easternmost May 3, 2017 IR location (also less than 5 gallons). HDD operations were shut down immediately and the IRs cleaned up using a vacuum truck. At the time of these IRs, the pilot bit from the west-side drilling was 682 feet from the west entry point and 106 feet bgs.
- **August 2, 2018:** Lost approximately 70% circulation during drilling Joint #50, at a bit location 1,011 feet from east side entry point. Two IRs were observed on the west side of LeTort Spring Run. The first IR occurred in the permitted IR Containment BMP at STATION 10117+00 and the second IR occurred in an upland area on the west side of LeTort Spring Run at the same location the July 25, 2018 IR occurred. At the time of the IRs, the pilot bit was located at 1,021 feet from the east side entry point. Pretec stopped advancing the pilot bit and pumped 1,000 gallons of LCM into the borehole.
- **August 6, 2018:** During trip in activities, permitted IR Containment BMP at STATION 10117+00 was reactivated. Pretec pumped/recirculated drilling fluid from the containment area back to the west side reclaimer.
- **August 23, 2018:** A new IR was observed on the west side HDD at STATION 10113+32 (Note: this IR location has since been approved by the PA DEP as a permitted IR Containment BMP). Pretec cleaned up approximately 80 gallons of drilling fluid. Upon submittal of documentation to the PA DEP from Sunoco/ETP, the PA DEP grants restart approval to Sunoco/ETP.
- **August 24, 2018:** Pretec completed the pilot hole for the 20-inch HDD.
- **August 26, 2018:** Pretec began 22-inch diameter pull-ream from west to east.

- **September 4, 2018:** LOR of approximately 8,000 – 10,000 gallons of drilling fluid was reported by Pretec, at which time the 22-inch reamer bit was located 1,054 feet from the west side entry point. Pretec stopped operations and pumped 10,000 gallons of LCM into the borehole. During placement of the LCM and subsequent flushing of drill rods, an upland IR occurred at STATION 10122+21 (Note: this IR location has since been approved by the PA DEP as a permitted IR Containment BMP). Pretec cleaned up approximately 25 gallons of drilling fluid released to the ground surface using a vacuum truck.
- **September 5, 2018:** Pretec started 30-inch pull-reaming from west to east to open up the boring and improve returns.
- **September 11, 2018:** Pretec stopped pull-reaming with a 30-inch reamer bit at 1,039.5 feet from the west entry point and resumed pull-reaming with a 22-inch reamer bit from west to east.
- **September 13, 2018:** A new IR, located within LeTort Spring Run at STATION 10125+37, initially released approximately 2 gallons of drilling fluid into LeTort Spring Run. At the time of the IR, the 22-inch reamer bit was approximately 1,364 feet from the west entry point. Pretec cleaned up the release and drilling fluid that had settled on the stream bed using a vacuum truck. During subsequent placement of approximately 2,000 gallons of LCM into the borehole, the IR reactivated and an additional estimated 6 gallons of drilling fluid was released into LeTort Spring Run. This additional drilling fluid was also cleaned up by Pretec using a vacuum truck. As a result, an estimated total of 7 gallons of drilling fluid was released as a result of this IR. HDD operations ceased pending restart approval by the PA DEP.
- **September 14-25, 2018**: Upon restart approval, Pretec mobilized a drill rig to the west side and 22-inch pull-reaming was resumed from east to west and was completed on September 17, 2018. During the remainder of the 22-inch reaming, and during the 30-inch reaming (completed on September 19, 2018) and subsequent swab passes, reactivations of permitted IR Containment BMPs occurred but there were no new IRs. The 20-inch pipe was successfully pulled on September 25, 2018.

8.0 CONCEPTUAL HYDROGEOLOGIC MODEL AND CONCLUSION

Based on published geologic and hydrogeologic information, geotechnical borings, field observations and geophysical surveys, the LeTort Spring Run HDD is underlain by carbonate rocks of the St. Paul Group composed primarily of very finely crystalline limestone and dolomite. The hydrogeologic setting is dominated by groundwater flow that occurs in secondary openings along geologic features that include bedding planes, joints, faults and fractures. In these carbonate rocks, these well-developed secondary openings are enlarged or enhanced by dissolution to provide moderate to high permeability. Water-bearing zones, including those that supply water wells, generally occur at relatively shallow depths below the ground surface. Water-bearing zones in the St. Paul Group are abundant at shallow depths and typically extend to depths of approximately 250 feet bgs.

The originally proposed 16-inch HDD profile was relatively shallow at the entry and exit points and passed through both the unconsolidated overburden and fractured bedrock. Based on the hydro-structural characteristics of the underlying geology described in this report and the previous occurrence of IRs during installation of the 20-inch pipe, the LeTort Spring Run HDD site is susceptible to an IR of drilling fluids during HDD operations. As a result, the HDD profile has been redesigned to allow for deeper crossings

beneath the wetlands and streams. The revised profile is approximately 115 feet below LeTort Spring Run (this is approximately 17 feet deeper than the 20-inch pipe). The inclination of the entry and exit angles has been increased to allow the pipe to be installed through protective soils, residual soils, and bedrock, and in closer proximity to the entry and exit points than the original, shorter and shallower profile. From a geologic perspective, the longer and deeper profile, in conjunction with the proposed engineering controls and/or drilling best management practices, will be used to reduce the risk of an IR and/or a loss of drilling fluid. Drilling procedures should account for the variability in bedrock strength and fractures. This includes the immediate suspension of drilling activity, and concurrent assessment, at the initial sign of any drilling fluid loss in accordance with the procedures and Containment BMPs implemented by the ME II HDD program in the summer of 2018.

9.0 REFERENCES

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10.0 CERTIFICATION

The studies and evaluations presented in this report (other than Section 5.0) were completed under the direction of a licensed professional geologist (PG) and are covered under the PG seals that follow.

By affixing my seal to this document, I am certifying that, to my knowledge and belief, the information herein is true and correct. I further certify, that I am licensed to practice in the Commonwealth of Pennsylvania and that it is within my professional expertise to verify the correctness of the information herein.

Douglas J. Hess, PG
License No. PG000186G

Ethan E. Prout, PG
License No. PG003884

Christopher T. Brixius, PG
License No. PG004765

Enclosure

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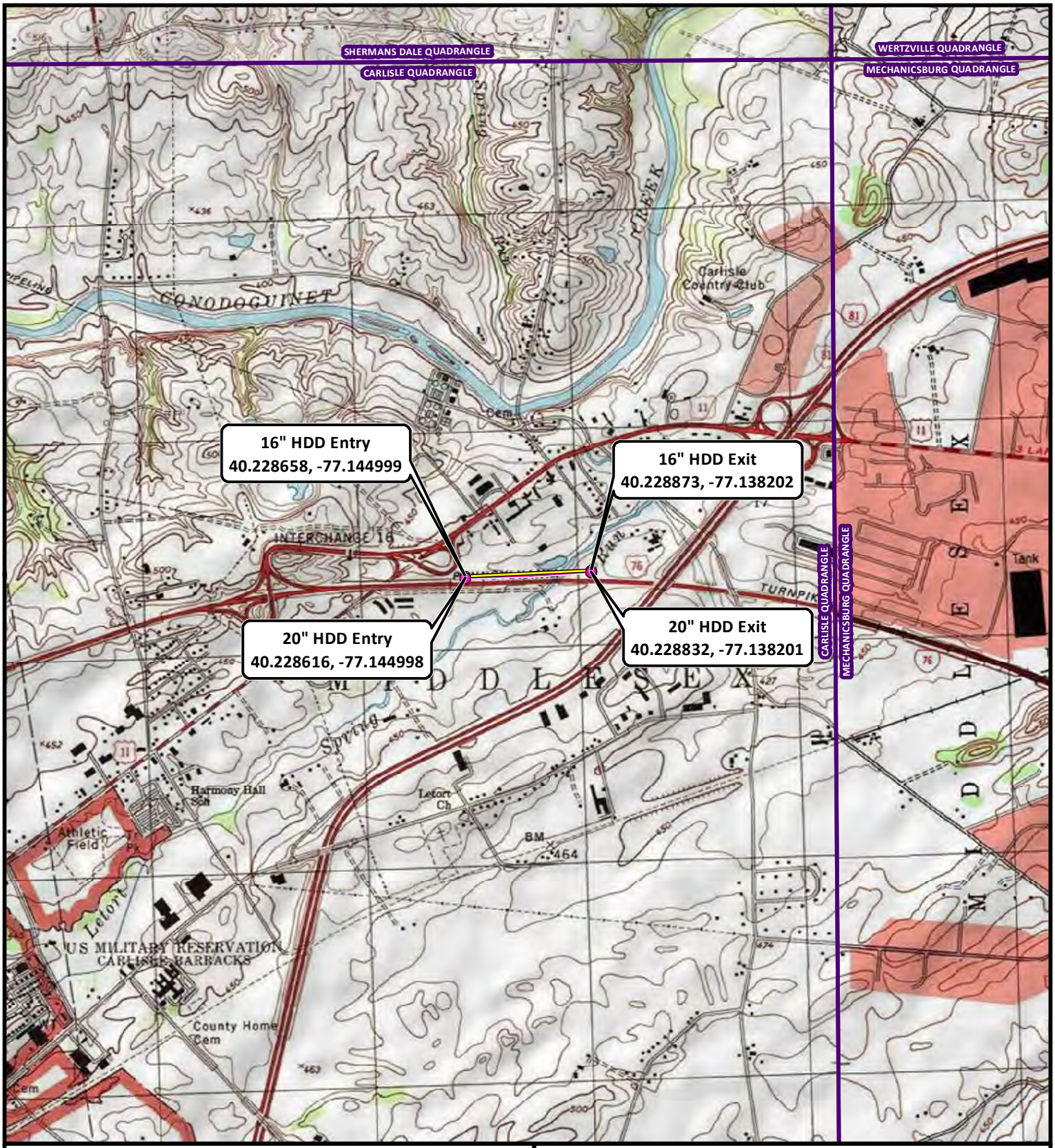
RETTEW

FIGURES



16" HDD Entry/Exit

20" HDD Entry/Exit

16" HDD Profile

20" HDD Profile

Carlisle, PA USGS 7.5' Topographic Quadrangle

1/25/2019

Sunoco Pipeline, L.P.

LeTort Spring Run HDD Location

Figure 1 - Topographic Basemap

Middlesex Township, Cumberland County, PA

Project No. 096302011

N S E W

0 1,000 2,000 Feet

1 inch = 2,000 feet

Service Layer Credits: Copyright:© 2013 National Geographic Society, i-cubed

Sunoco Logistics Partners L.P.

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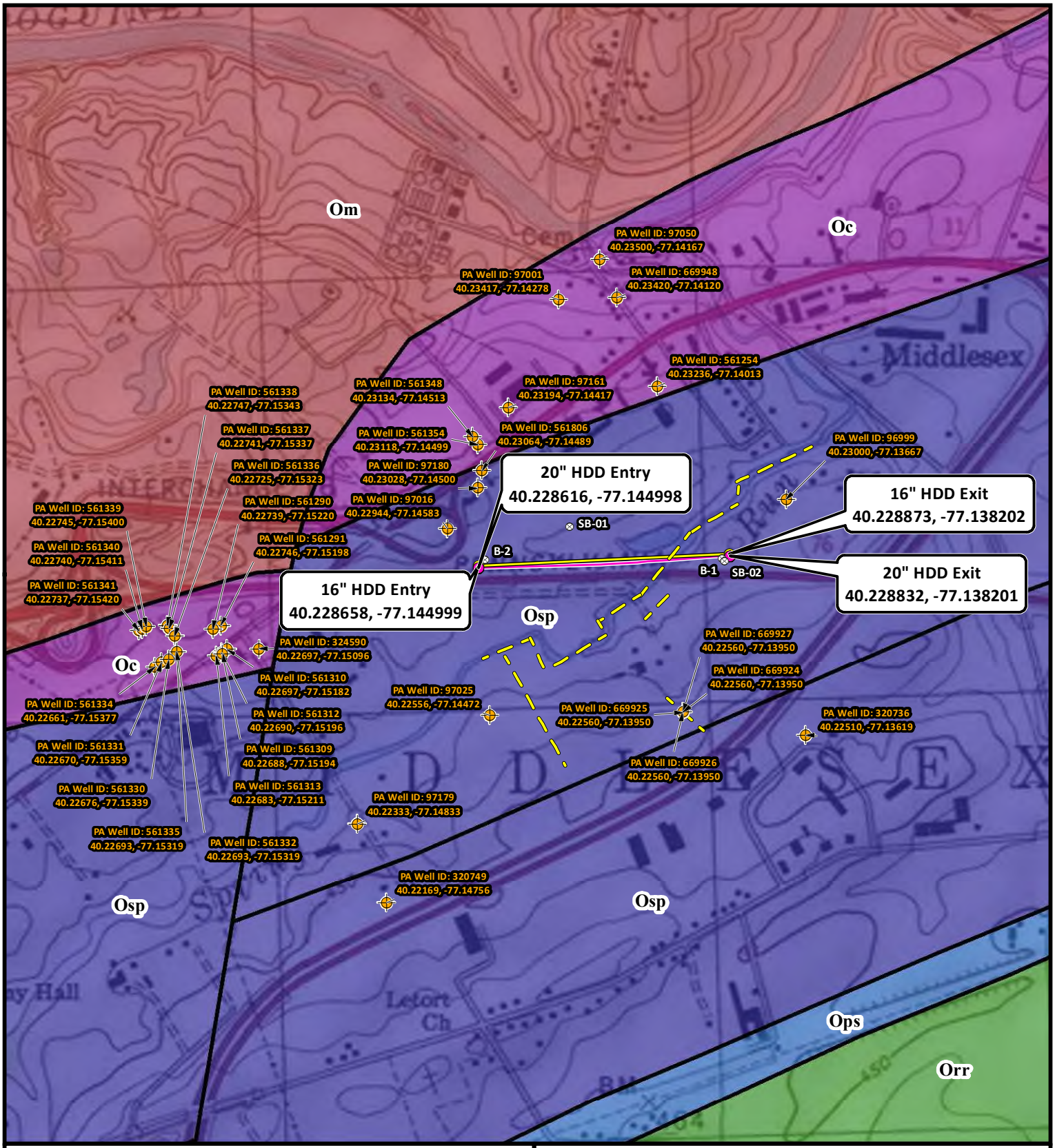

Residential Well
Soil Boring
16" HDD Entry/Exit
20" HDD Entry/Exit
16" HDD Profile
20" HDD Profile
Inferred Fracture Trace

Geologic Formation

- Oc - Chambersburg Formation
- Om - Martinsburg Formation
- Ops - Pinesburg Station Formation
- Orr - Rockdale Run Formation
- Osp - St. Paul Group

Carlisle, PA USGS 7.5' Topographic Quadrangle

1/25/2019

Sunoco Pipeline, L.P.

LeTort Spring Run HDD Location

Figure 2 - Geologic Map

Middlesex Township, Cumberland County, PA

Project No. 096302011

N W E S

0 500 1,000 Feet

1 inch = 1,000 feet

Service Layer Credits: Copyright:© 2013 National Geographic Society, i-cubed

Sunoco Logistics Partners L.P.

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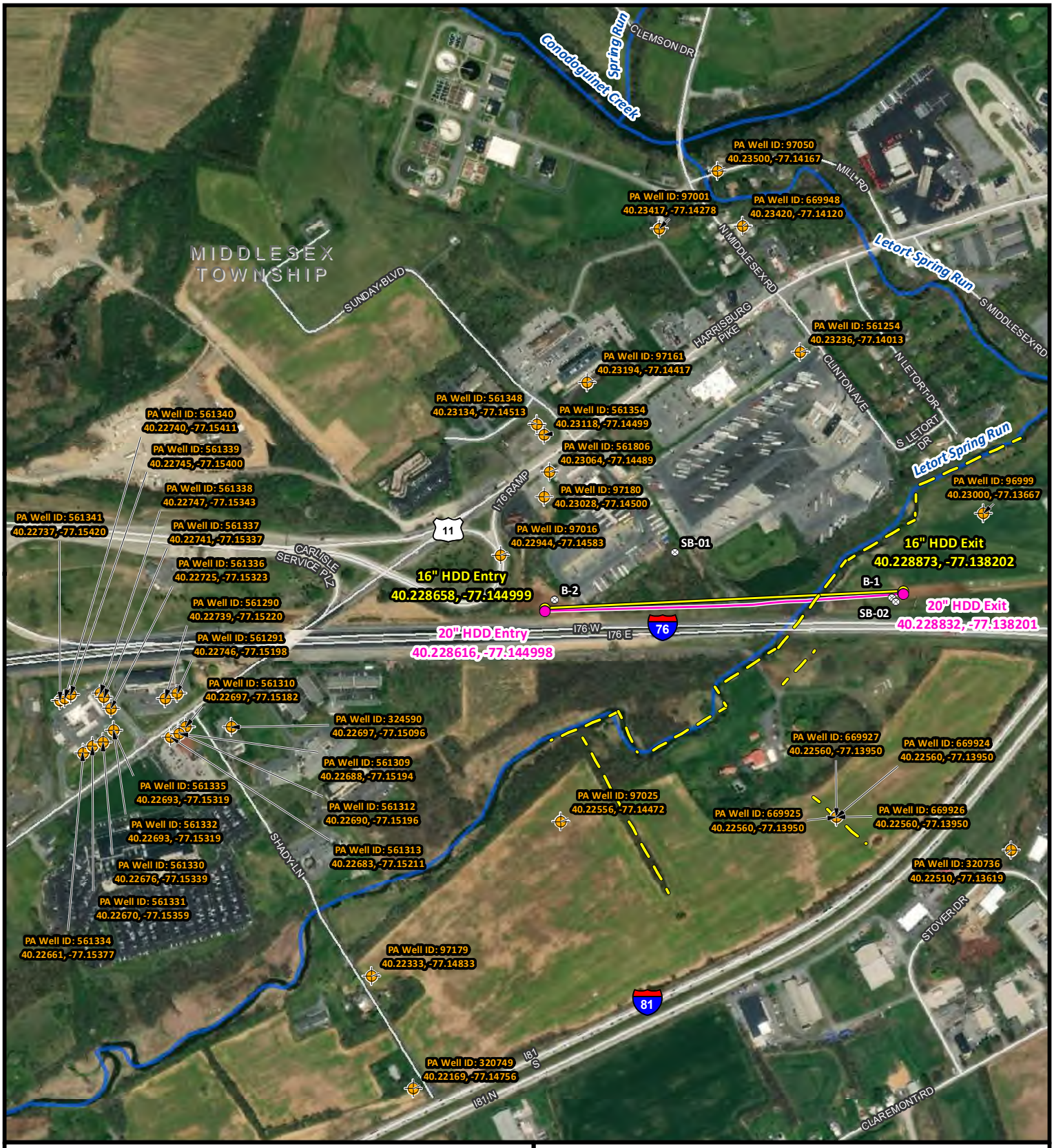

Residential Well

Soil Boring

16" HDD Entry/Exit

20" HDD Entry/Exit

16" HDD Profile

20" HDD Profile

Inferred Fracture Trace

NHD Stream

Road

1/25/2019

Sunoco Pipeline, L.P.

LeTort Spring Run HDD Location

Figure 3 - Aerial Basemap

Middlesex Township, Cumberland County, PA

Project No. 096302011

N W E S

0 700 Feet

1 inch = 700 feet

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Sunoco Logistics Partners L.P.

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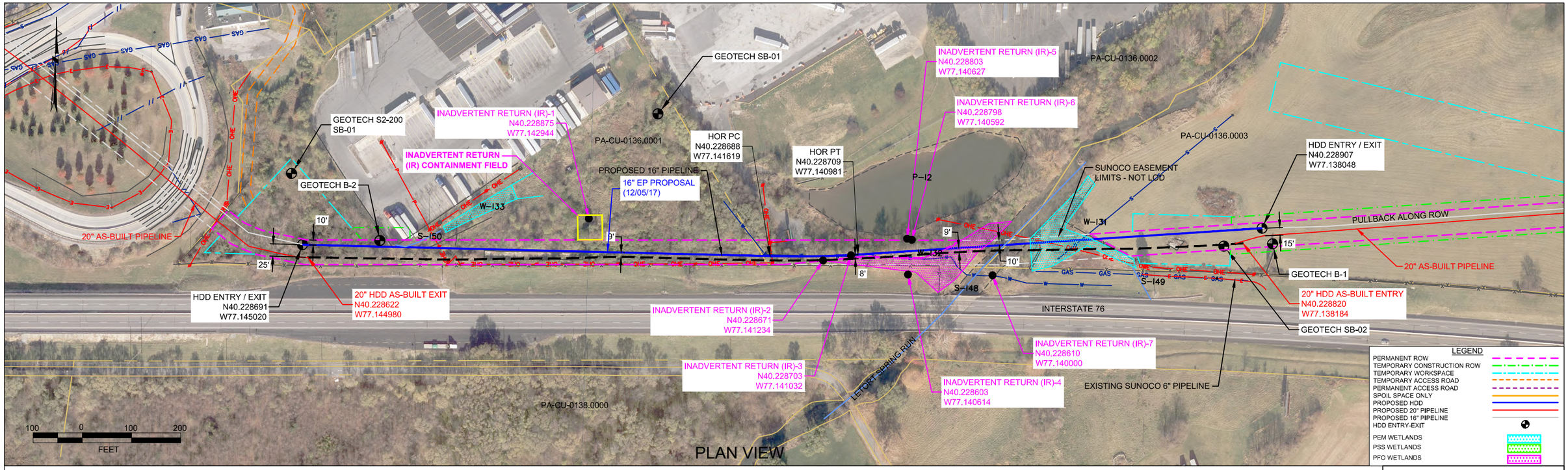
RETTEW

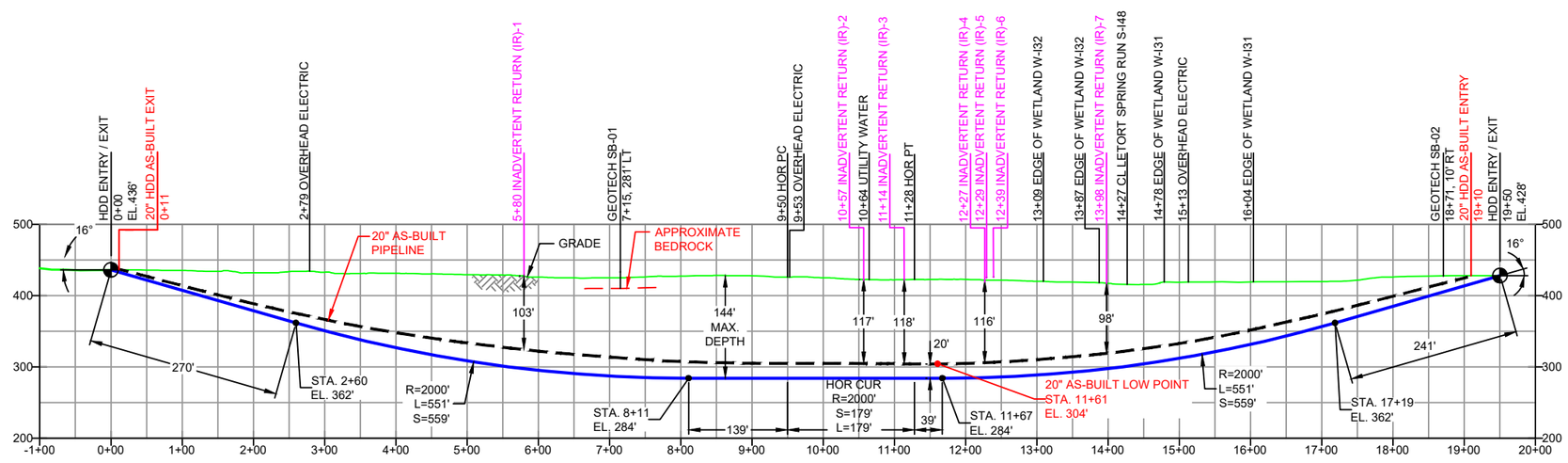
ATTACHMENT 1
HDD PROFILES AND GEOTECHNICAL BORING LOGS



PLAN VIEW

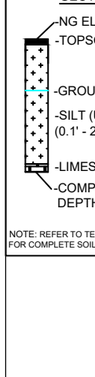
CUMBERLAND COUNTY, PENNSYLVANIA - MIDDLESEX TOWNSHIP
S2-0210-16

PROFILE VIEW



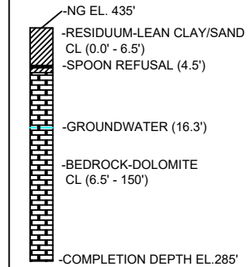
GEOTECH SB-01

GEOTECH SB-02



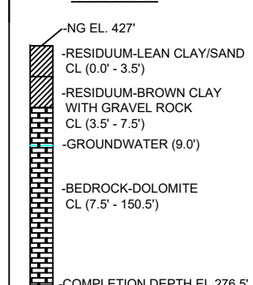
NOTE: REFER TO TEST BORING LOG S2-0200 FOR COMPLETE SOIL MATERIAL DESCRIPTION

GEOTECH B-2



NOTE: REFER TO TEST BORING LOG B-2 INTERTEK / PSI PROJECT #04911412 FOR COMPLETE SOIL MATERIAL DESCRIPTION

GEOTECH B-1



NOTE: REFER TO TEST BORING LOG B-1 INTERTEK / PSI PROJECT #04911412 FOR COMPLETE SOIL MATERIAL DESCRIPTION

DESIGN AND CONSTRUCTION:

1. CONTRACTOR SHALL FIELD VERIFY DEPTH OF ALL EXISTING UTILITIES SHOWN OR NOT SHOWN ON THIS DRAWING.
2. THE MINIMUM SEPARATION DISTANCE FROM EXISTING SUBSURFACE UTILITIES SHALL NOT BE LESS THAN 10 FEET AS MEASURED FROM THE OUTSIDE EDGE OF THE UTILITY TO OUTSIDE OF PROPOSED PIPELINE.
3. DESIGNED IN ACCORDANCE WITH CFR 49 195 & ASME B31.4
4. CROSSING PIPE SPECIFICATION:
   HDD HORZ. LENGTH (L=): 1950'
   HDD PIPE LENGTH (S=): 1986'
   16" x 0.438" W.T., X-70, API5L, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 40 MILS MIN. ARO (POWERCRETE R95)
5. INTERNAL DESIGN PRESSURE 2100 PSIG (SEAM FACTOR 1.0, DESIGN FACTOR 0.50 (HOOP STRESS)).
6. INSTALLATION METHOD: HORIZONTAL DIRECTIONAL DRILL (HDD).
7. PIPELINE WARNING MARKERS SHALL BE INSTALLED ON BOTH SIDES OF ALL ROAD, RAILWAY, AND STREAM CROSSINGS.
8. CARRIER PIPE NOT ENCASED.
9. PIPE / AMBIENT TEMPERATURE MUST BE NO LESS THAN 30°F DURING PULLBACK WITHOUT PRIOR WRITTEN APPROVAL FROM THE ENGINEER.
10. CONDUCT 4-HOUR PRE-INSTALLATION HYDROTEST OF HDD PIPE STRING TO MINIMUM 2625 PSIG.
11. SEE SUNOCO PENNSYLVANIA PIPELINE PROJECT ESRI WEBMAP FOR ACCESS ROAD ALIGNMENT.
12. SUNOCO PIPELINE, L.P.'S HORIZONTAL DIRECTIONAL DRILL INADVERTENT RETURN CONTINGENCY PLAN WILL BE IMPLEMENTED AT ALL TIMES.
13. SUNOCO PIPELINE, L.P.'S EROSION AND SEDIMENTATION CONTROL PLAN WILL BE IMPLEMENTED AT ALL TIMES.

NOTES

1. ALL COORDINATES SHOWN ARE IN LATITUDE AND LONGITUDE. ALL MSL ELEVATIONS ARE NAD83
2. STATIONING IS BASED ON HORIZONTAL DISTANCES.
3. ROONEY ENGINEERING, INC. AND SUNOCO PIPELINE, LP ARE NOT RESPONSIBLE FOR LOCATION OF FOREIGN UTILITIES SHOWN IN PLOT PLAN OR PROFILE. THE INFORMATION SHOWN HEREON IS FURNISHED WITHOUT LIABILITY ON THE PART OF ROONEY ENGINEERING, INC. AND SUNOCO PIPELINE, LP. FOR ANY DAMAGES RESULTING FROM ERRORS OR OMISSIONS THEREIN.
4. CONTRACTOR IS RESPONSIBLE FOR LOCATING ALL UTILITIES. CONTACT ONE CALL AT 811 PRIOR TO DIGGING.
5. SUNOCO EMERGENCY HOTLINE NUMBER IS #1-800-786-7440.

REF. DRAWING

DWG NO		DWG NO	DESCRIPTION
ES-4.57	TO	ES-4.58	EROSION & SEDIMENT PLAN
SHEET 36	TO	SHEET 37	AERIAL SITE PLAN

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP5	DESIGN CHANGE - INCREASED DEPTH OF DRILL	MRS	12/11/18	RMB	12/11/18	AMC	12/11/18
EP4	UPDATED NOTE 5 AND 10 PER INCREASED 16" MOP	MRS	04/10/18	RMB	04/10/18	CAG	04/10/18
EP3	LOWERED DRILL AND RELOCATED ENTRY/EXIT - DESIGN CHANGE REQUESTED BY CLIENT	MRS	12/05/17	RMB	12/05/17	CAG	12/05/17
EP2	REVISED PER PADEP COMMENTS RECEIVED 09-06-16	MRS	10/07/16	RMB	10/07/16	AAW	10/07/16
EP1	REVISED PER PADEP COMMENTS	MRS	05/10/16	RMB	05/10/16	AAW	05/10/16
EP		JTW	03/23/16	RMB	03/23/16	AAW	03/23/16

Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

HORIZONTAL DIRECTIONAL DRILL
LETORT SPRING RUN
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=200'

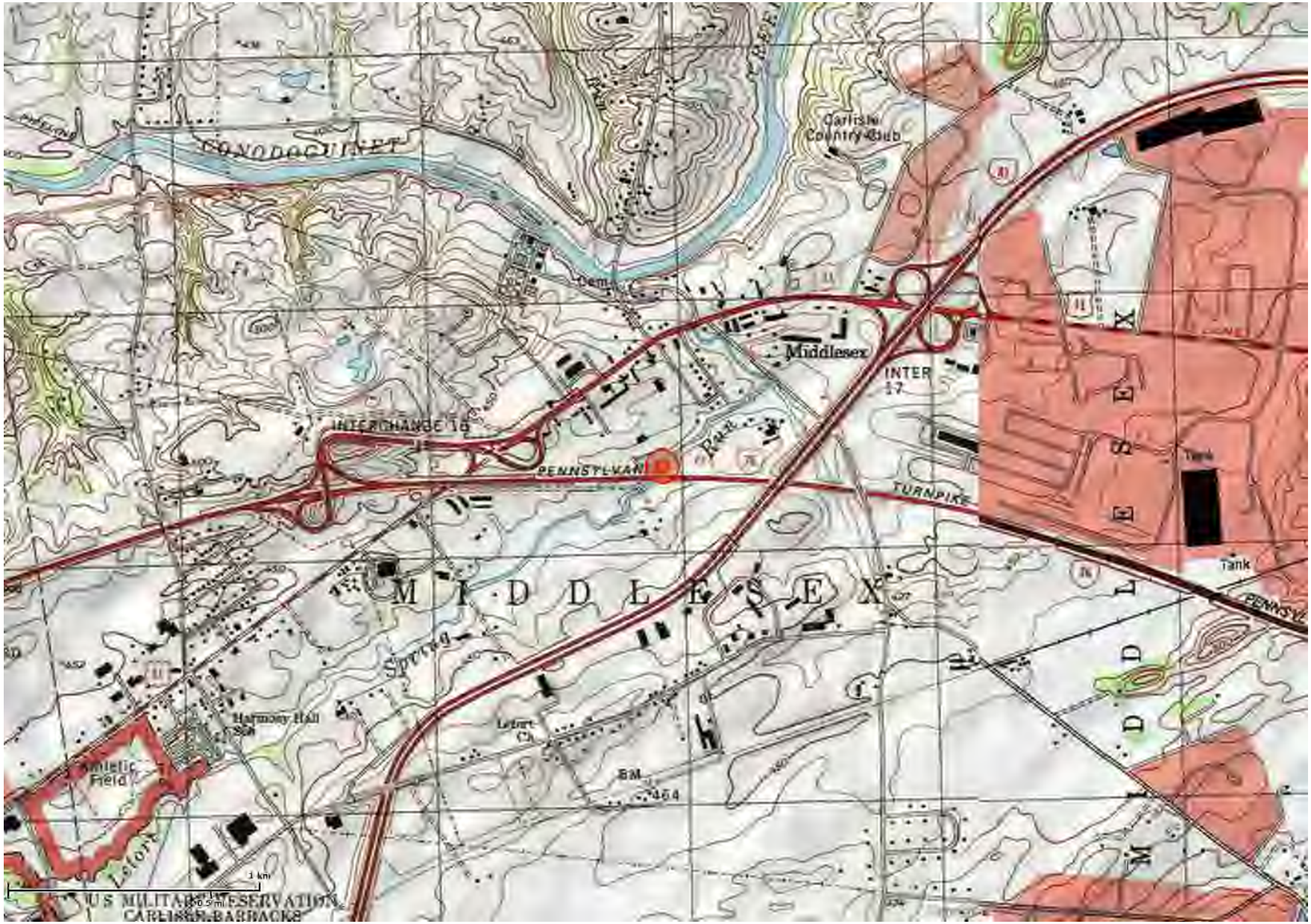
DWG. NO: PA-CU-0136.0002-WX-16

pennsylvania
DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES

Visit us at http://www.dcnr.state.pa.us

Figure 1: Site Vicinity Map

Make online reservations at
www.visitPAparks.com
or call toll-free 888-PA-PARKS

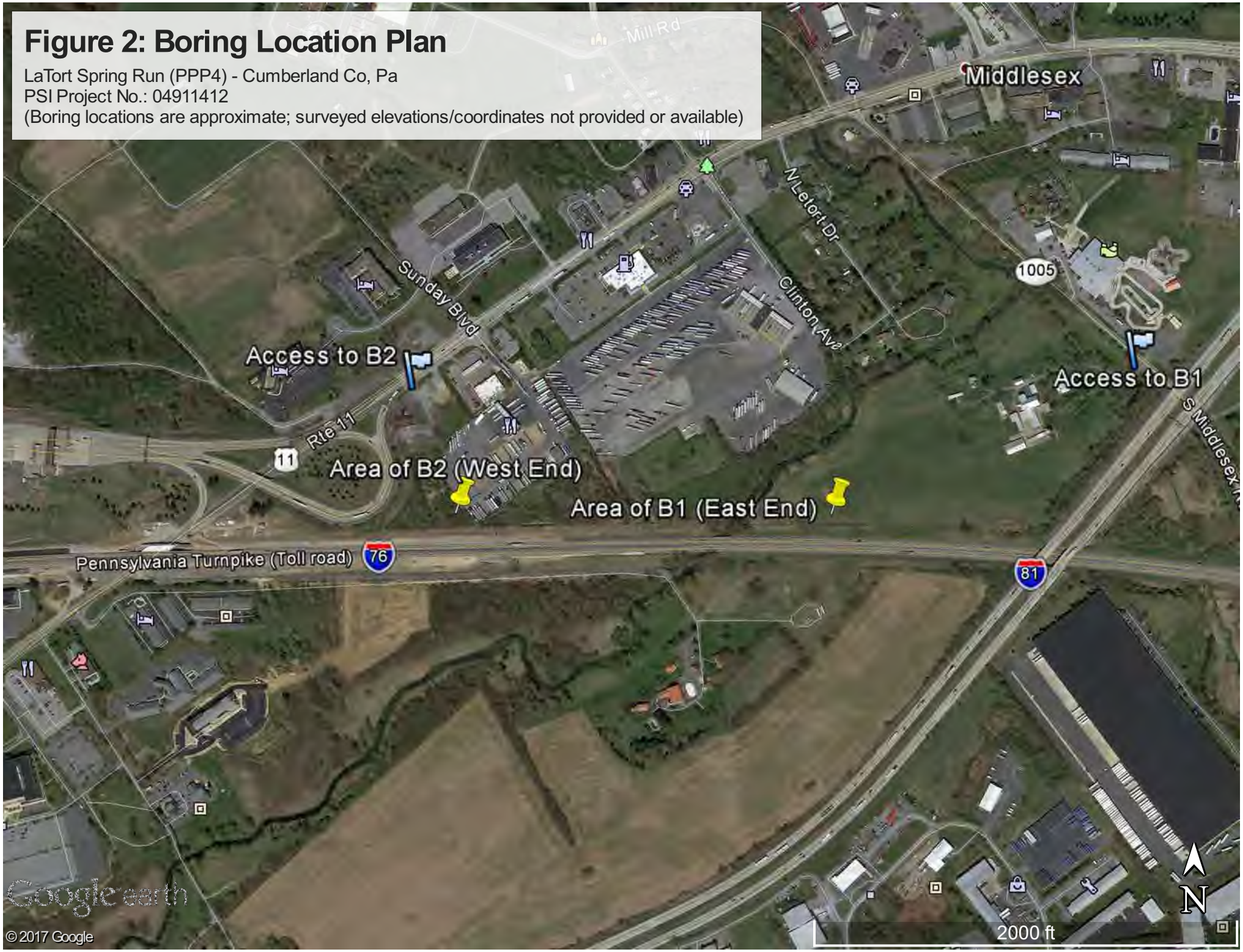


Created using PA DCNR Map Viewer

Map created on Tue Jul 18 2017

Figure 2: Boring Location Plan

LaTort Spring Run (PPP4) - Cumberland Co, Pa
PSI Project No.: 04911412
(Boring locations are approximate; surveyed elevations/coordinates not provided or available)



SINKHOLES AND KARST-RELATED FEATURES
OF CUMBERLAND COUNTY, PENNSYLVANIA

by W.E.Kochanov

1989

OPEN FILE REPORT: 8902

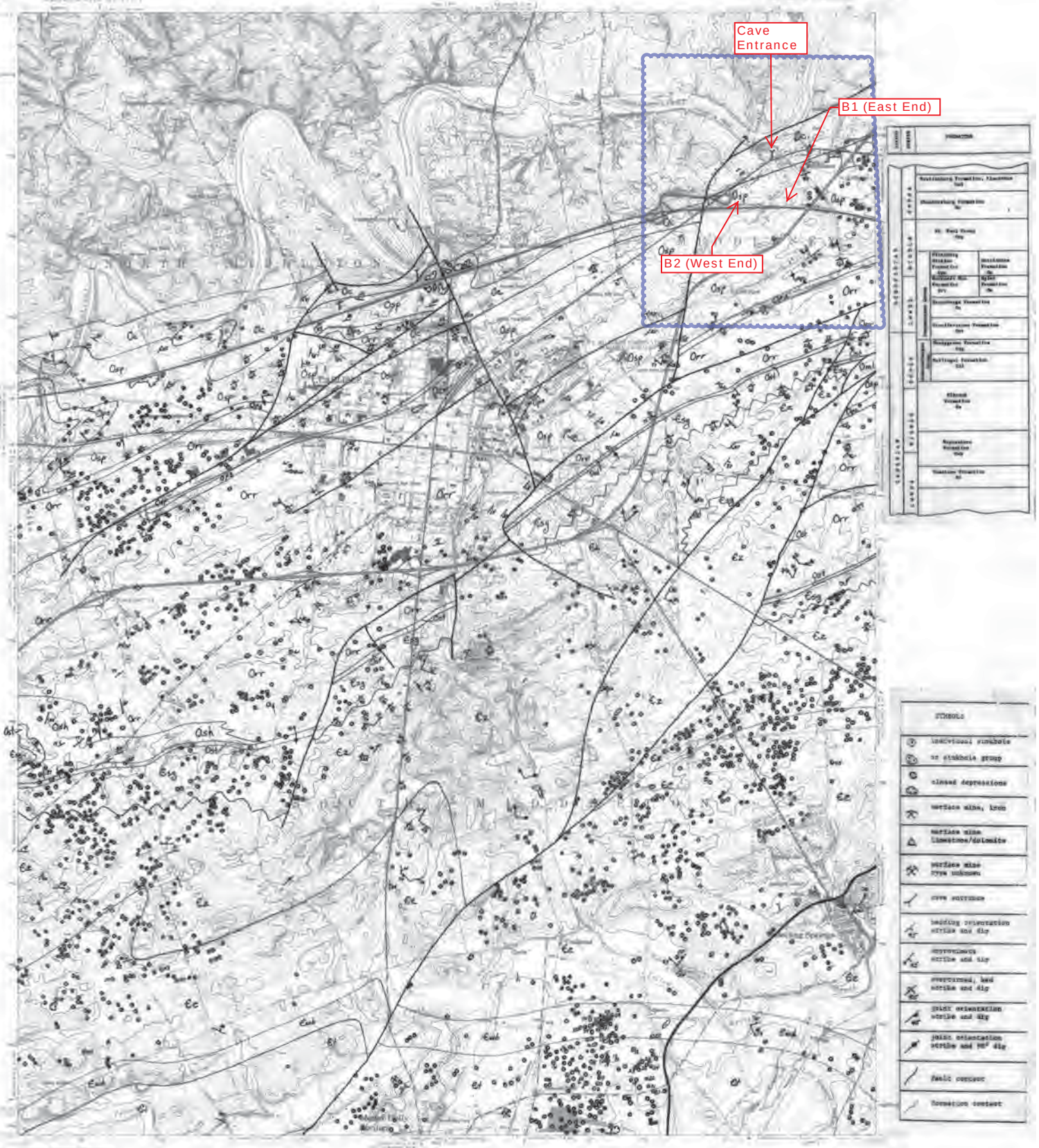


FIGURE 3: Karst/Geology Map
LaTort Spring Run (PPP4)
PSI Project No. 04911412

The work presented here has not been reviewed for formal publication.

Bureau of Topographic and Geologic Survey
P.O. Box 8453, Harrisburg, PA 17105-8453

BORING B-1

DATE STARTED:	6/26/17	**DRILL COMPANY:**	Eichelberger's, Inc.
DATE COMPLETED:	6/27/17	**DRILLER:**	**LOGGED BY:** F. Hoffman
COMPLETION DEPTH	150.5 ft	**DRILL RIG:**	Diedrich D-50 Track Rig
BENCHMARK:	N/A	**DRILLING METHOD:**	Rollerbit/Rock Coring
ELEVATION:	N/A	**SAMPLING METHOD:**	2-in SS1.874-in Core
LATITUDE:	n/a°	**HAMMER TYPE:**	Automatic
LONGITUDE:	n/a°	**EFFICIENCY**	N/A
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	P. McMichael

Water: Pre-Coring — Not Enc.; Post-Coring — 9 feet

BORING LOCATION: See Boring Location Plan

REMARKS: Boring location selected in the field (no surveyed ground EL or coordinates provided)

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ (Moisture ✕, PL ◪, LL ✚; 0–25–50) / STRENGTH, tsf ▲ Qu ✳ Qp (0–2.0–4.0)	Additional Remarks
	0			S-1	13	**RESIDUUM**- Medium Stiff, Brown, Lean CLAY with Sand, moist	CL	4-3-3-3 N=6		◎	
	5			R-1	27	**RESIDUUM**- A split-spoon sample was attempted from 5 to 7 feet; however, a pinnacle was encountered which bent the sampler making recovery of the sample impossible. Coring operations were initiated at 5 feet bgs with soil being encountered until approximately 7-1/2 feet bgs. Recovered soil consisted of brown clay with gravel-sized rock fragments.	CL	RQD=28 Rec=45%			2 min. 2 min. 2 min. 3 min.
	10			R-2	49	**BEDROCK**- Light gray to dark gray, **Dolomite**, Very fine-grained, Slightly Weathered to Weathered, diagonal to nearly vertical fractures Highly Weathered Zone from 9 to 9.1 feet. Weathered Fracture @ 10.3 feet (nearly vertical) Presumed soil zone from approximately 10.7 to 11.9 feet. No sample was recovered between these depths and it is assumed that the soil washed out of the core barrel. Weathered Fracture @ 11.9 feet (diagonal)		RQD=60 Rec=81%			3 min. 3 min. >>▲Q_u = 1201.6 tsf 5 min.
	15			R-3	59	**BEDROCK**- Gray, **Dolomite**, Very fine-grained, Slightly Weathered, horizontal to diagonal fractures Appx. 1/4-inch thick soil seam @ 15 feet Weathered Fracture @ 19.1 feet (nearly horizontal)		RQD=96 Rec=98%			3 min. 4 min. 4 min. 3 min. 4 min.
	20			R-4	53	Weathered Fracture @ 20.9 feet (diagonal) Weathered Fracture @ 22.8 feet (horizontal)		RQD=87 Rec=88%			4 min. 3 min. 2 min. 3 min. 3 min.
	25										3 min.

Continued Next Page

Professional Service Industries, Inc.
1707 S. Cameron Street, Suite B
Harrisburg, PA 17104
Telephone: (717) 230-8622

PROJECT NO.: 04911412
PROJECT: Energy Transfer HDD (DPS)
LOCATION: LaTort Spring Run (PPP4)
Carlisle
Cumberland Co, PA

The stratification lines represent approximate boundaries. The transition may be gradual.

BORING B-1

DATE STARTED:	6/26/17	**DRILL COMPANY:**	Eichelberger's, Inc.
DATE COMPLETED:	6/27/17	**DRILLER:**	**LOGGED BY:** F. Hoffman
COMPLETION DEPTH	150.5 ft	**DRILL RIG:**	Diedrich D-50 Track Rig
BENCHMARK:	N/A	**DRILLING METHOD:**	Rollerbit/Rock Coring
ELEVATION:	N/A	**SAMPLING METHOD:**	2-in SS1.874-in Core
LATITUDE:	n/a°	**HAMMER TYPE:**	Automatic
LONGITUDE:	n/a°	**EFFICIENCY**	N/A
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	P. McMichael

Water: Pre-Coring — Not Enc.; Post-Coring — 9 feet

BORING LOCATION: See Boring Location Plan

REMARKS: Boring location selected in the field (no surveyed ground EL or coordinates provided)

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ (× Moisture, ◪ PL, ✚ LL; 0–25–50) STRENGTH, tsf (▲ Qu, ✳ Qp; 0–2.0–4.0)	Additional Remarks
				R-5	48	**BEDROCK**- Gray, **Dolomite**, Very fine-grained, Highly Weathered, broken		RQD=81 Rec=100%			3 min. 3 min. 3 min. 4 min.
	30			R-6	56	**BEDROCK**- Light gray to dark gray, **Dolomite**, Very fine-grained, Slightly Weathered, horizontal to nearly vertical fractures		RQD=68 Rec=93%			2 min. 5 min. 5 min. 5 min. 3 min.
	35			R-7	48	Highly Weathered Zone from 35.5 to 35.6 feet. Weathered Fracture @35.6 feet (horizontal) Weathered Fracture @ 36.2 feet (diagonal)		RQD=94 Rec=100%			3 min. 3 min. 4 min. 5 min. 3 min.
	40			R-8	60	Moderate Rx to 10%HCL Highly Weathered Zone from 41.8 to 42.1 feet. Weathered Fracture @ 42.8 feet (diagonal, quartz in fracture) Weathered Fracture @ 43.4 feet (diagonal)		RQD=90 Rec=100%		>>▲Qu = 875.5 tsf	3 min. 3 min. 4 min. 4 min.
	45			R-9	47			RQD=97 Rec=98%			3 min. 3 min. 4 min.
	50			R-10	60	Weathered Fracture @ 49.5 feet (diagonal)		RQD=100 Rec=100%			4 min. 4 min.

Continued Next Page

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PROJECT NO.: 04911412
PROJECT: Energy Transfer HDD (DPS)
LOCATION: LaTort Spring Run (PPP4)
Carlisle
Cumberland Co, PA

The stratification lines represent approximate boundaries. The transition may be gradual.

BORING B-1

DATE STARTED:	6/26/17	**DRILL COMPANY:**	Eichelberger's, Inc.
DATE COMPLETED:	6/27/17	**DRILLER:**	**LOGGED BY:** F. Hoffman
COMPLETION DEPTH	150.5 ft	**DRILL RIG:**	Diedrich D-50 Track Rig
BENCHMARK:	N/A	**DRILLING METHOD:**	Rollerbit/Rock Coring
ELEVATION:	N/A	**SAMPLING METHOD:**	2-in SS1.874-in Core
LATITUDE:	n/a°	**HAMMER TYPE:**	Automatic
LONGITUDE:	n/a°	**EFFICIENCY**	N/A
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	P. McMichael

Water: Pre-Coring — Not Enc.; Post-Coring — 9 feet

BORING LOCATION: See Boring Location Plan

REMARKS: Boring location selected in the field (no surveyed ground EL or coordinates provided)

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ (× Moisture, ◪ PL, ✚ LL; 0–25–50) / STRENGTH, tsf (▲ Qu, ✳ Qp; 0–2.0–4.0)	Additional Remarks
						BEDROCK- Light gray to dark gray, **Dolomite**, Very fine-grained, Slightly Weathered, horizontal to nearly vertical fractures					5 min.
											3 min.
				R-11	60			RQD=88 Rec=100%			4 min.
	55										
						Weathered Fracture @ 55.5 feet (nearly vertical)					2 min.
						Highly Weathered Zone from 55.6 to 56 feet.					5 min.
						Weathered Fracture @ 56 feet (nearly horizontal)					3 min.
						Moderate Rx to 10%HCL					>> ▲ Q_u = 1249.4 tsf
											4 min.
				R-12	60			RQD=98 Rec=100%			3 min.
	60										
						Weathered Fracture @ 60.5 feet (horizontal)					5 min.
											5 min.
											3 min.
											3 min.
				R-13	60			RQD=97 Rec=100%			5 min.
	65										
											2 min.
						Weathered Fracture @ 66.8 feet (horizontal)					3 min.
											3 min.
											3 min.
				R-14	60	Weathered Fracture @ 69.6 feet (diagonal)		RQD=100 Rec=100%			3 min.
	70										
											5 min.
						Weathered Fracture @ 71.6 feet (nearly horizontal)					4 min.
											3 min.
											3 min.
				R-15	60			RQD=98 Rec=100%			2 min.
	75										
						Weathered/Mechanical Fracture @ 75 feet (diagonal, broke when handled)					3 min.
						Weathered Fracture @ 75.5 feet (diagonal)					
						Weathered Fracture @ 76 feet (nearly vertical)					5 min.
						Moderate Rx to 10%HCL					>> ▲ Q_u = 927.0 tsf

Continued Next Page

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PROJECT NO.: 04911412
PROJECT: Energy Transfer HDD (DPS)
LOCATION: LaTort Spring Run (PPP4)
Carlisle
Cumberland Co, PA

The stratification lines represent approximate boundaries. The transition may be gradual.

BORING B-1

DATE STARTED:	6/26/17	**DRILL COMPANY:**	Eichelberger's, Inc.
DATE COMPLETED:	6/27/17	**DRILLER:**	**LOGGED BY:** F. Hoffman
COMPLETION DEPTH	150.5 ft	**DRILL RIG:**	Diedrich D-50 Track Rig
BENCHMARK:	N/A	**DRILLING METHOD:**	Rollerbit/Rock Coring
ELEVATION:	N/A	**SAMPLING METHOD:**	2-in SS1.874-in Core
LATITUDE:	n/a°	**HAMMER TYPE:**	Automatic
LONGITUDE:	n/a°	**EFFICIENCY**	N/A
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	P. McMichael

Water: Pre-Coring — Not Enc.; Post-Coring — 9 feet

BORING LOCATION: See Boring Location Plan

REMARKS: Boring location selected in the field (no surveyed ground EL or coordinates provided)

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ (× Moisture, ◪ PL, ✚ LL; 0–25–50) / STRENGTH, tsf (▲ Qu, ✳ Qp; 0–2.0–4.0)	Additional Remarks
						BEDROCK- Gray to light gray, **Dolomite**, Very fine-grained, Weathered to Highly Weathered					5 min.
											5 min.
				R-16	60	Weathered Fracture @ 78.3 feet (nearly vertical)		RQD=62 Rec=100%			
	80										4 min.
						Weathered Fracture @ 79 feet (horizontal)					2 min.
						Weathered Fracture @ 80.5 feet (nearly horizontal)					3 min.
						Weathered Fracture @ 82.4 feet (nearly vertical, soil in fracture)					6 min.
				R-17	37	**BEDROCK**- Light gray to dark gray, **Dolomite**, Very fine-grained, Slightly Weathered, nearly horizontal to vertical fractures		RQD=38 Rec=88%			6 min.
	85										5 min.
						Weathered Fracture @ 84.4 feet (nearly vertical, soil in fracture)					3 min.
						Soil Layer from 84.5 to 85 feet.					6 min.
						Highly Weathered Zone from 85 to 85.5 feet.					5 min.
				R-18	60	Broken/very broken layer from 85.5 to 86.6 feet; some quartz.		RQD=87 Rec=100%			4 min.
						Weathered Fracture @ 86.3 feet (nearly vertical)					3 min.
						Developing Fracture @ 88.8 feet (vertical)					
	90										4 min.
				R-19	18			RQD=100 Rec=100%			3 min.
											5 min.
										>>▲ Qu = 1162.5 tsf	4 min.
											5 min.
				R-20	60			RQD=100 Rec=100%			
	95										4 min.
											4 min.
											5 min.
											4 min.
											4 min.
				R-21	60			RQD=100 Rec=100%			
	100										2 min.
						Weathered Fracture @ 100.6 feet (nearly horizontal)					4 min.
											3 min.
											4 min.

Continued Next Page

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PROJECT NO.: 04911412
PROJECT: Energy Transfer HDD (DPS)
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Carlisle
Cumberland Co, PA

The stratification lines represent approximate boundaries. The transition may be gradual.

BORING B-1

DATE STARTED:	6/26/17	**DRILL COMPANY:**	Eichelberger's, Inc.
DATE COMPLETED:	6/27/17	**DRILLER:**	**LOGGED BY:** F. Hoffman
COMPLETION DEPTH	150.5 ft	**DRILL RIG:**	Diedrich D-50 Track Rig
BENCHMARK:	N/A	**DRILLING METHOD:**	Rollerbit/Rock Coring
ELEVATION:	N/A	**SAMPLING METHOD:**	2-in SS1.874-in Core
LATITUDE:	n/a°	**HAMMER TYPE:**	Automatic
LONGITUDE:	n/a°	**EFFICIENCY**	N/A
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	P. McMichael

Water: Pre-Coring — Not Enc.; Post-Coring — 9 feet

BORING LOCATION: See Boring Location Plan

REMARKS: Boring location selected in the field (no surveyed ground EL or coordinates provided)

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ (× Moisture, ◪ PL, ✚ LL; 0–25–50) / STRENGTH, tsf (▲ Qu, ✳ Qp; 0–2.0–4.0)	Additional Remarks
	105			R-22	60	**BEDROCK**- Gray to dark gray, **Dolomite**, Very fine-grained, Slightly Weathered, horizontal to nearly vertical fractures Developing Fracture @ 104.2 feet (diagonal) Weathered Fracture @ 104.8 feet (diagonal) Weathered Fracture @ 105.7 feet (diagonal) Broken Zone from 105.7 to 107 feet.		RQD=73 Rec=100%			4 min. 5 min. 3 min. 4 min. 4 min. 4 min.
	110			R-23	55	Low Rx to 10%HCL Weathered Fracture @ 110.7 feet (horizontal) Developing Fracture @ 111.2 feet (nearly vertical) Weathered Fracture @ 111.8 feet (nearly horizontal) Broken Zone from 113.1 to 113.4 feet.		RQD=71 Rec=92%			3 min. 5 min. 6 min. 3 min.
	115			R-24	48	**BEDROCK**- Light gray to gray, **Dolomite**, Very fine-grained, Slightly Weathered, horizontal to nearly vertical fractures Developing Fracture @ 113.7 feet (nearly vertical) Developing Fractures @ 114.2 feet (horizontal & diagonal)		RQD=92 Rec=100%		>>▲Qu = 1049.7 tsf	4 min. 5 min. 4 min. 4 min.
	120			R-25	60	**BEDROCK**- Gray to dark gray, **Dolomite**, Very fine-grained, Slightly Weathered, horizontal to nearly vertical fractures (Little to No Rx to 10%HCl) Weathered Fracture @ 116.3 feet (nearly vertical) Developing Fracture @ 117.7 feet (nearly vertical)		RQD=73 Rec=100%			4 min. 4 min. 3 min. 4 min.
	125			R-26	30	Weathered Fracture @ 118.4 feet (diagonal) Weathered Fracture @ 119.3 feet (nearly vertical) Weathered Fracture @ 119.4 feet (nearly horizontal) **BEDROCK**- Gray to black, **Dolomite**, Very fine-grained, Slightly Weathered to Weathered, broken		RQD=30 Rec=100%			4 min. 3 min.
	130			R-27	42	**BEDROCK**- Light gray to gray, **Limestone**, Very fine-grained to fine-grained, Slightly Weathered, horizontal to nearly vertical fractures (Low Rx to 10%HCl) Weathered Zone from 128.6 to 128.8 feet.		RQD=86 Rec=100%			4 min. 4 min. 4 min.
				R-28	60			RQD=72			4 min.

Continued Next Page

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PROJECT NO.: 04911412
PROJECT: Energy Transfer HDD (DPS)
LOCATION: LaTort Spring Run (PPP4)
Carlisle
Cumberland Co, PA

The stratification lines represent approximate boundaries. The transition may be gradual.

BORING B-1

DATE STARTED:	6/26/17	**DRILL COMPANY:**	Eichelberger's, Inc.
DATE COMPLETED:	6/27/17	**DRILLER:**	**LOGGED BY:** F. Hoffman
COMPLETION DEPTH	150.5 ft	**DRILL RIG:**	Diedrich D-50 Track Rig
BENCHMARK:	N/A	**DRILLING METHOD:**	Rollerbit/Rock Coring
ELEVATION:	N/A	**SAMPLING METHOD:**	2-in SS1.874-in Core
LATITUDE:	n/a°	**HAMMER TYPE:**	Automatic
LONGITUDE:	n/a°	**EFFICIENCY**	N/A
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	P. McMichael

Water: Pre-Coring — Not Enc.; Post-Coring — 9 feet

BORING LOCATION: See Boring Location Plan

REMARKS: Boring location selected in the field (no surveyed ground EL or coordinates provided)

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ (× Moisture, ◪ PL, ✚ LL; 0–25–50) / STRENGTH, tsf (▲ Qu, ✳ Qp; 0–2.0–4.0)	Additional Remarks
	130					**BEDROCK**- Light gray to gray, **Limestone**, Very fine-grained to fine-grained, Slightly Weathered, horizontal to nearly vertical fractures (Low Rx to 10%HCl)		Rec=100%			4 min.
											4 min.
						Weathered Fracture @ 130.1 feet (diagonal)					4 min.
						Weathered Zone from 131.3 to 131.7 feet.					4 min. >> Q_u = 1082.4 tsf
											3 min.
				R-29	60			RQD=100 Rec=100%			
	135										3 min.
											4 min.
											4 min.
											4 min.
						Multiple Developing Fractures from 137.6 to 138.5 feet (nearly vertical).					4 min.
				R-30	60	Developing Fracture @ 139.2 feet (horizontal)		RQD=99 Rec=99%			
	140										3 min.
											4 min.
						Weathered Fracture @ 141.2 feet (nearly horizontal, quartz in fracture)					4 min.
											4 min.
						Low to Moderate Rx to 10%HCL					4 min.
				R-31	60			RQD=100 Rec=100%			
	145										4 min.
						Developing Fracture from 144.6 to 146.3 feet (nearly vertical, broke when handled)					4 min.
											3 min.
											5 min.
				R-32	42			RQD=100 Rec=100%			>> Q_u = 1016.7 tsf 3 min.
	150										5 min.
											4 min.
						Test boring terminated @ 150.5 feet					

Professional Service Industries, Inc.
1707 S. Cameron Street, Suite B
Harrisburg, PA 17104
Telephone: (717) 230-8622

PROJECT NO.: 04911412
PROJECT: Energy Transfer HDD (DPS)
LOCATION: LaTort Spring Run (PPP4)
Carlisle
Cumberland Co, PA

The stratification lines represent approximate boundaries. The transition may be gradual.

BORING B-2

DATE STARTED:	6/28/17	**DRILL COMPANY:**	Eichelberger's, Inc.
DATE COMPLETED:	6/29/17	**DRILLER:**	**LOGGED BY:** F. Hoffman
COMPLETION DEPTH	150.0 ft	**DRILL RIG:**	Diedrich D-50 Track Rig
BENCHMARK:	N/A	**DRILLING METHOD:**	Rollerbit/Rock Coring
ELEVATION:	N/A	**SAMPLING METHOD:**	2-in SS1.874-in Core
LATITUDE:	n/a°	**HAMMER TYPE:**	Automatic
LONGITUDE:	n/a°	**EFFICIENCY**	N/A
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	P. McMichael

Water

Pre-Coring	Not Enc.
Post-Coring	16.3 feet

BORING LOCATION:
See Boring Location Plan

REMARKS: Boring location selected in the field (no surveyed ground EL or coordinates provided)

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ (Moisture ✕, PL ◪, LL ✚; 0–25–50) / STRENGTH, tsf ▲ Qu ✳ Qp (0–2.0–4.0)	Additional Remarks
	0			S-1	19	**RESIDUUM**-Brown, Lean CLAY, trace Sand, moist	CL	2-4-4-6 N=8		◎	
	5					Rollerbit Refusal @ 4.5 feet					
				R-1	31	**BEDROCK**- Gray, **Dolomite**, Very fine-grained, Highly Weathered, broken		RQD=0 Rec=74%			3 min. 2 min.
						Weathered Fracture @ 8.9 feet (diagonal)					2 min.
	10			R-2	52	**BEDROCK**- Light gray to gray, **Dolomite**, Very fine-grained, Slightly Weathered to Weathered, horizontal to vertical fractures Weathered Fracture @ 9.4 feet (nearly horizontal) Weathered Fracture @ 9.5 feet (nearly horizontal, quartz in fracture) Developing Fractures @ 9.9 feet (nearly horizontal & vertical) Weathered Fracture @ 10.2 feet (nearly horizontal) Weathered Zone from 10.5 to 11.1 feet.		RQD=39 Rec=86%			3 min. 5 min. 3 min. 4 min. >> ▲ Q_u = 608.4 tsf 3 min. 3 min.
	15			R-3	60	**BEDROCK**- Light gray to gray, **Dolomite**, Very fine-grained, Slightly Weathered, horizontal to vertical fractures (Low Rx to 10%HCL) Developing Fractures from 15.2 to 16.4 feet (diagonal to nearly vertical) Developing Fractures @ 16.8 feet (nearly vertical) Developing Fracture @ 17.5 feet (diagonal) Weathered Zone from 19.5 to 19.7 feet.		RQD=97 Rec=99%			2 min. 2 min. 4 min.
	20			R-4	30	Weathered Zone from 20.5 to 21.5 feet.		RQD=80 Rec=100%			3 min. 3 min. 1 min. 3 min.
	25			R-5	47			RQD=76 Rec=87%			2 min. 3 min. 3 min.

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Professional Service Industries, Inc.
1707 S. Cameron Street, Suite B
Harrisburg, PA 17104
Telephone: (717) 230-8622

PROJECT NO.: 04911412
PROJECT: Energy Transfer HDD (DPS)
LOCATION: LaTort Spring Run (PPP4)
Carlisle
Cumberland Co, PA

The stratification lines represent approximate boundaries. The transition may be gradual.

BORING B-2

DATE STARTED:	6/28/17	**DRILL COMPANY:**	Eichelberger's, Inc.
DATE COMPLETED:	6/29/17	**DRILLER:**	**LOGGED BY:** F. Hoffman
COMPLETION DEPTH	150.0 ft	**DRILL RIG:**	Diedrich D-50 Track Rig
BENCHMARK:	N/A	**DRILLING METHOD:**	Rollerbit/Rock Coring
ELEVATION:	N/A	**SAMPLING METHOD:**	2-in SS1.874-in Core
LATITUDE:	n/a°	**HAMMER TYPE:**	Automatic
LONGITUDE:	n/a°	**EFFICIENCY**	N/A
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	P. McMichael

Water: Pre-Coring — Not Enc.; Post-Coring — 16.3 feet

BORING LOCATION: See Boring Location Plan

REMARKS: Boring location selected in the field (no surveyed ground EL or coordinates provided)

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ (× Moisture, ◪ PL, ✚ LL; 0–25–50) STRENGTH, tsf (▲ Qu, ✳ Qp; 0–2.0–4.0)	Additional Remarks
				R-6	60	**BEDROCK**- Light gray to gray, **Dolomite**, Very fine-grained, Slightly Weathered, horizontal to vertical fractures (Low Rx to 10%HCL) Weathered Fracture @ 27.2 feet (diagonal)		RQD=100 Rec=100%			3 min. 3 min. 3 min. 3 min. 3 min. 3 min.
	30										
				R-7	60	Weathered Fracture @ 31.6 feet (diagonal) **BEDROCK**- Dark gray, **Dolomite**, Very fine-grained, Highly Weathered, very broken **BEDROCK**- Light gray to gray, **Dolomite**, Very fine-grained, Slightly Weathered, horizontal to diagonal fractures (Low to Moderate Rx to 10%HCL)		RQD=77 Rec=100%			4 min. 5 min. 3 min.
	35					Weathered Fracture @ 34.1 feet (nearly horizontal) Weathered Zone from 34.8 to 35 feet. Granular Weathered Zone from 35.7 to 36 feet.					5 min. 4 min. 4 min.
				R-8	60	Weathered Fracture @ 36.5 feet (nearly horizontal) Weathered Fracture @ 37.4 feet (diagonal) Weathered Fracture @ 37.8 feet (horizontal) **BEDROCK**- Dark gray to light gray-brown, **Dolomite**, Very fine-grained, Weathered to Highly Weathered, broken (Low to Moderate Rx to 10%HCL)		RQD=49 Rec=100%			3 min. 3 min. 2 min. 2 min.
	40			R-9	60	**BEDROCK**- Gray to dark gray, **Dolomite**, Fine-grained to very fine-grained, Slightly Weathered, horizontal to nearly vertical fractures (Moderate Rx to 10%HCL)		RQD=97 Rec=100%		>>Qu = 607.1 tsf	3 min. 4 min. 3 min.
	45					Weathered Fracture @ 46.2 feet (horizontal)					2 min. 3 min.
				R-10	60			RQD=100 Rec=100%			4 min. 4 min. 2 min.
	50					Weathered Fracture @ 50.8 feet (diagonal)					3 min. 3 min.

Continued Next Page

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Telephone: (717) 230-8622

PROJECT NO.: 04911412
PROJECT: Energy Transfer HDD (DPS)
LOCATION: LaTort Spring Run (PPP4)
Carlisle
Cumberland Co, PA

The stratification lines represent approximate boundaries. The transition may be gradual.

BORING B-2

DATE STARTED:	6/28/17	**DRILL COMPANY:**	Eichelberger's, Inc.
DATE COMPLETED:	6/29/17	**DRILLER:**	**LOGGED BY:** F. Hoffman
COMPLETION DEPTH	150.0 ft	**DRILL RIG:**	Diedrich D-50 Track Rig
BENCHMARK:	N/A	**DRILLING METHOD:**	Rollerbit/Rock Coring
ELEVATION:	N/A	**SAMPLING METHOD:**	2-in SS1.874-in Core
LATITUDE:	n/a°	**HAMMER TYPE:**	Automatic
LONGITUDE:	n/a°	**EFFICIENCY**	N/A
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	P. McMichael

Water: Pre-Coring — Not Enc.; Post-Coring — 16.3 feet

BORING LOCATION: See Boring Location Plan

REMARKS: Boring location selected in the field (no surveyed ground EL or coordinates provided)

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ (× Moisture, ◪ PL, ✚ LL; 0–25–50) / STRENGTH, tsf (▲ Qu, ✳ Qp; 0–2.0–4.0)	Additional Remarks
				R-11	60	**BEDROCK**- Gray to dark gray, **Dolomite**, Fine-grained to very fine-grained, Slightly Weathered, horizontal to nearly vertical fractures (Moderate Rx to 10%HCL)		RQD=100 Rec=100%			3 min. 3 min. 3 min.
	55										4 min. 4 min. 3 min.
				R-12	59	Moderate Rx to 10%HCL		RQD=75 Rec=98%		>>▲ 723.0 tsf	3 min. 2 min.
	60					Weathered Fracture @ 59.5 feet (nearly vertical) Developing Fracture @ 60 feet (nearly vertical)					3 min. 3 min.
				R-13	59	**BEDROCK**- Light gray to dark gray, **Dolomite**, Fine-grained to very fine-grained, Slightly Weathered, horizontal to nearly vertical fractures Weathered Fracture @ 61.5 feet (horizontal)		RQD=95 Rec=98%			3 min. 3 min. 3 min.
	65										4 min. 4 min. 4 min.
				R-14	56	Weathered Zone from 66.4 to 66.7 feet.		RQD=79 Rec=93%			2 min. 2 min.
	70					Weathered Fracture Zone from 68.9 to 69.2 feet. Appx. 1/4-inch thick soil seam @ 70 feet					2 min. 3 min. 3 min.
				R-15	60			RQD=75 Rec=100%			2 min. 3 min.
	75					Weathered Fracture @ 73.8 feet (diagonal) Broken Dolomite Zone from 74.1 to 74.5 feet. Broken Zone from 74.5 to 75 feet.					3 min. 3 min. 3 min.
				R-16	60			RQD=100			

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Telephone: (717) 230-8622

PROJECT NO.: 04911412
PROJECT: Energy Transfer HDD (DPS)
LOCATION: LaTort Spring Run (PPP4)
Carlisle
Cumberland Co, PA

The stratification lines represent approximate boundaries. The transition may be gradual.

BORING B-2

DATE STARTED:	6/28/17	**DRILL COMPANY:**	Eichelberger's, Inc.
DATE COMPLETED:	6/29/17	**DRILLER:**	**LOGGED BY:** F. Hoffman
COMPLETION DEPTH	150.0 ft	**DRILL RIG:**	Diedrich D-50 Track Rig
BENCHMARK:	N/A	**DRILLING METHOD:**	Rollerbit/Rock Coring
ELEVATION:	N/A	**SAMPLING METHOD:**	2-in SS1.874-in Core
LATITUDE:	n/a°	**HAMMER TYPE:**	Automatic
LONGITUDE:	n/a°	**EFFICIENCY**	N/A
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	P. McMichael

Water: Pre-Coring — Not Enc.; Post-Coring — 16.3 feet

BORING LOCATION: See Boring Location Plan

REMARKS: Boring location selected in the field (no surveyed ground EL or coordinates provided)

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ (× Moisture, ◪ PL, ✚ LL; 0–25–50) / STRENGTH, tsf (▲ Qu, ✳ Qp; 0–2.0–4.0)	Additional Remarks
						BEDROCK- Light gray to dark gray, **Dolomite**, Fine-grained to very fine-grained, Slightly Weathered, horizontal to nearly vertical fractures		Rec=100%			2 min. 3 min. 3 min.
	80										
				R-17	60			RQD=98 Rec=100%		>>▲ Q_u = 912.2 tsf	
	85					Developing Fractures @ 84.7 feet (nearly vertical) Weathered Fracture @ 85.3 feet (nearly vertical)					4 min. 3 min. 4 min.
				R-18	60	Weathered Fracture @ 87.8 feet (diagonal)		RQD=88 Rec=100%			4 min. 3 min.
	90					Weathered Fracture @ 89.5 feet (diagonal) Weathered Fracture @ 90.6 feet (diagonal) Weathered Fracture @ 91.6 feet (diagonal)					4 min. 3 min.
				R-19	58	Weathered Fracture @ 92.3 feet (nearly horizontal)		RQD=96 Rec=96%			3 min. 4 min.
	95					Weathered Fracture @ 94.3 feet (nearly horizontal)				>>▲ Q_u = 1136.8 tsf	4 min. 4 min.
				R-20	54	Developing Fracture @ 97.1 feet (diagonal) Weathered Fracture @ 98.8 feet (diagonal)		RQD=94 Rec=100%			3 min. 3 min. 4 min.
	100										4 min.
				R-21	54	Weathered Fracture @ 101.2 feet (diagonal) **BEDROCK**- Light blue-gray to gray, **Dolomite**, Fine-grained to very fine-grained, Slightly Weathered, horizontal to vertical fractures (Low Rx to 10%HCL)		RQD=100 Rec=100%			4 min. 5 min. 3 min.

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PROJECT NO.: 04911412
PROJECT: Energy Transfer HDD (DPS)
LOCATION: LaTort Spring Run (PPP4)
Carlisle
Cumberland Co, PA

The stratification lines represent approximate boundaries. The transition may be gradual.

BORING B-2

DATE STARTED:	6/28/17	**DRILL COMPANY:**	Eichelberger's, Inc.
DATE COMPLETED:	6/29/17	**DRILLER:**	**LOGGED BY:** F. Hoffman
COMPLETION DEPTH	150.0 ft	**DRILL RIG:**	Diedrich D-50 Track Rig
BENCHMARK:	N/A	**DRILLING METHOD:**	Rollerbit/Rock Coring
ELEVATION:	N/A	**SAMPLING METHOD:**	2-in SS1.874-in Core
LATITUDE:	n/a°	**HAMMER TYPE:**	Automatic
LONGITUDE:	n/a°	**EFFICIENCY**	N/A
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	P. McMichael

Water: Pre-Coring — Not Enc.; Post-Coring — 16.3 feet

BORING LOCATION: See Boring Location Plan

REMARKS: Boring location selected in the field (no surveyed ground EL or coordinates provided)

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ (× Moisture, ◪ PL, ✚ LL; 0–25–50) / STRENGTH, tsf (▲ Qu, ✳ Qp; 0–2.0–4.0)	Additional Remarks
				R-22	12	Developing Fracture @ 103.5 feet (vertical) **BEDROCK**- Light blue-gray to gray, **Dolomite**, Fine-grained to very fine-grained, Slightly Weathered, horizontal to vertical fractures (Low Rx to 10%HCL) Developing Fracture @ 104.5 feet (nearly vertical)		RQD=100 Rec=100%			3 min. 2 min. 4 min. 2 min.
	105			R-23	60			RQD=100 Rec=100%			3 min. 2 min.
	110					Weathered Fracture @ 109.6 feet (nearly horizontal, quartz in fracture) (Low to No Rx to 10%HCL)					3 min. >> ▲ Q_u = 941.0 tsf
				R-24	60			RQD=88 Rec=100%			3 min. 2 min. 3 min.
	115					Developing Fracture @ 113.4 feet (nearly vertical) Weathered Fractures @ 114.5 feet (horizontal & vertical)					4 min. 5 min.
				R-25	58	Weathered Fracture @ 116.9 feet (nearly horizontal) **BEDROCK**- Gray to dark gray, **Dolomite**, Very fine-grained, Weathered, nearly vertical to vertical fractures Highly Weathered Zone from 118.6 to 119 feet.		RQD=38 Rec=97%			3 min. 3 min. 4 min.
	120					**BEDROCK**- Light blue-gray to gray, **Dolomite**, Fine-grained to very fine-grained, Slightly Weathered, nearly horizontal to vertical fractures					2 min. 4 min. 4 min.
				R-26	60	Weathered Fracture @ 120.1 feet (nearly vertical) Weathered Fracture @ 120.7 feet (nearly horizontal) Weathered to Highly Weathered Zone from 121.1 to 121.5 feet.		RQD=85 Rec=100%			4 min. >> ▲ Q_u = 850.3 tsf 4 min. 4 min.
	125					Weathered Fracture @ 121.8 feet (nearly vertical) Weathered Fracture @ 122 feet (nearly horizontal)					4 min. 4 min. 2 min.
				R-27	58	Weathered Fracture @ 123.6 feet (nearly horizontal) Low Rx to 10%HCL Weathered Fracture @ 124 feet (diagonal) Weathered Fracture @ 124.5 feet		RQD=87 Rec=97%			3 min. 4 min.
	130										

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PROJECT NO.: 04911412
PROJECT: Energy Transfer HDD (DPS)
LOCATION: LaTort Spring Run (PPP4)
Carlisle
Cumberland Co, PA

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BORING B-2

DATE STARTED:	6/28/17	**DRILL COMPANY:**	Eichelberger's, Inc.
DATE COMPLETED:	6/29/17	**DRILLER:**	**LOGGED BY:** F. Hoffman
COMPLETION DEPTH	150.0 ft	**DRILL RIG:**	Diedrich D-50 Track Rig
BENCHMARK:	N/A	**DRILLING METHOD:**	Rollerbit/Rock Coring
ELEVATION:	N/A	**SAMPLING METHOD:**	2-in SS1.874-in Core
LATITUDE:	n/a°	**HAMMER TYPE:**	Automatic
LONGITUDE:	n/a°	**EFFICIENCY**	N/A
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	P. McMichael

Water

Pre-Coring	Not Enc.
Post-Coring	16.3 feet

BORING LOCATION:
See Boring Location Plan

REMARKS: Boring location selected in the field (no surveyed ground EL or coordinates provided)

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ × Moisture ◪ PL ✚ LL (0 – 25 – 50) STRENGTH, tsf ▲ Qu ✳ Qp (0 – 2.0 – 4.0)	Additional Remarks
	130					Developing Fracture @ 127.3 feet					3 min.
						BEDROCK- Light blue-gray to gray, **Dolomite**, Fine-grained to very fine-grained, Slightly Weathered, nearly horizontal to vertical fractures					4 min.
											4 min.
				R-28	60	Weathered Fracture @ 130.5 feet (diagonal)		RQD=77 Rec=100%			
						Weathered Fracture @ 132.6 feet (nearly vertical)					4 min.
						Weathered Fracture @ 133 feet (nearly horizontal)					3 min.
	135					Developing Fracture @ 133.5 feet (vertical)					4 min.
											5 min.
											3 min.
				R-29	60			RQD=100 Rec=100%			4 min.
						Moderate Rx to 10%HCL					4 min.
	140										3 min.
						Weathered Fracture @ 141 feet (diagonal)					4 min.
						Developing Fracture @ 141.8 feet (nearly vertical)					3 min.
				R-30	56			RQD=76 Rec=93%			5 min.
											3 min.
	145										3 min.
				R-31	24			RQD=90 Rec=100%			4 min.
						Weathered Fracture @ 146.4 feet (diagonal)					3 min.
						Weathered/Highly Weathered Zone from 147 to 147.6 feet.					
				R-32	36	Weathered Fracture @ 147.6 feet (diagonal)		RQD=71 Rec=99%			
						Weathered Fracture @ 147.9 feet (diagonal)					
						Weathered Fracture @ 149.4 feet (horizontal)					
	150					Weathered Fracture @ 150 feet (horizontal)					
						Test boring terminated @ 150 feet					

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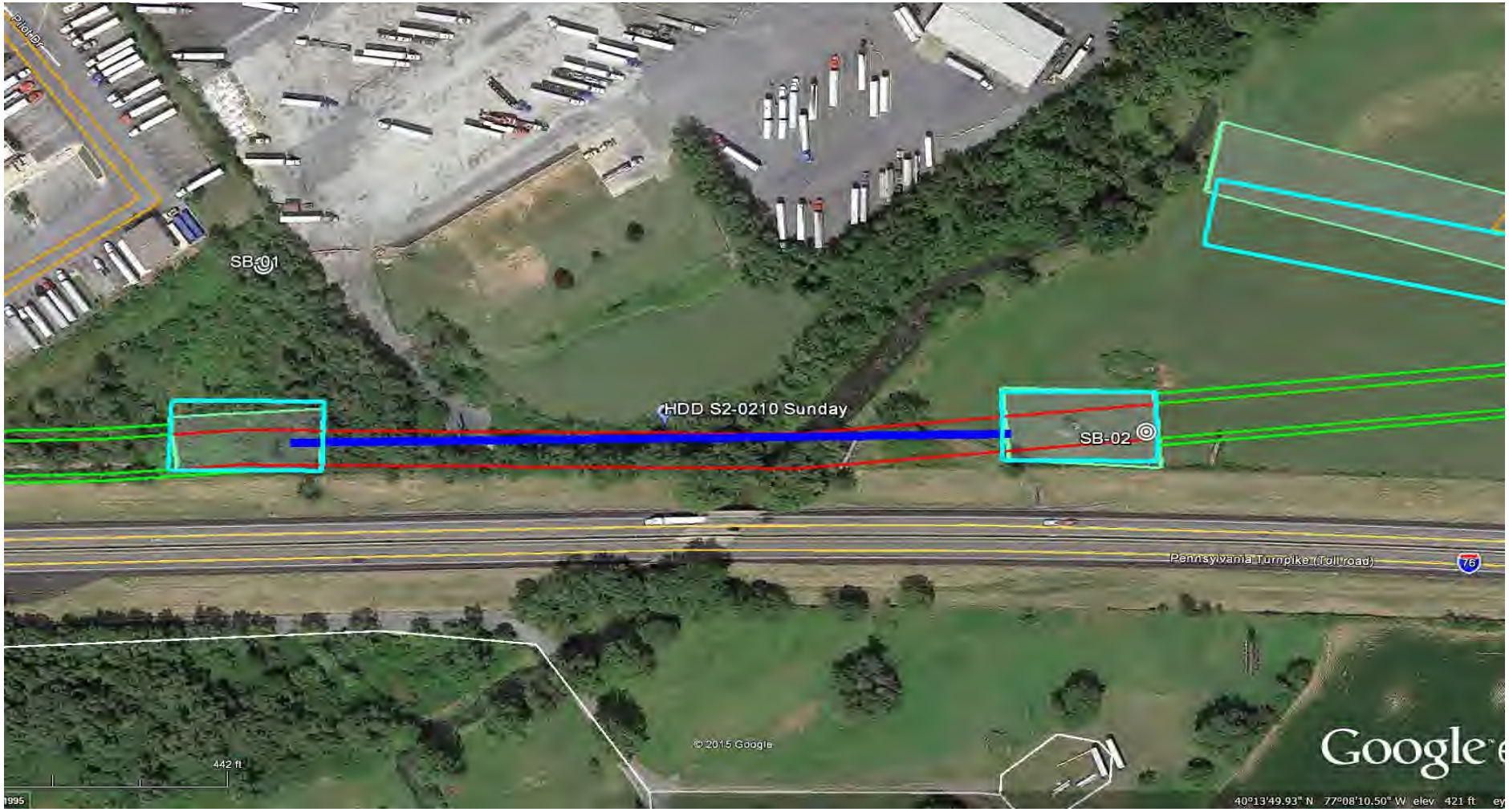
PROJECT NO.: 04911412
PROJECT: Energy Transfer HDD (DPS)
LOCATION: LaTort Spring Run (PPP4)
Carlisle
Cumberland Co, PA

The stratification lines represent approximate boundaries. The transition may be gradual.

PSI PROJ#	Crossing Desc.	Boring ID	Core Box #	Top Depth of Rock Core (ft)	Length of Core (in)	Length of Capped Core (in)	Rock Core Diameter, D (in)	Load (lbs)	Compressive Strength (psi)	Compressive Strength (psf)	L/D Ratio	L/D Correction	L/D Corrected Strength (psi)	L/D Corrected Strength (psf)	Remarks (Core Mass in Grams)
04911412	Good Spring Water Stream	B-1	1	12.1	3.72	3.90	1.99	52,340	16,828	2,423,261	1.8693	0.9917	16,688	2,403,124	512.3g
04911412	Good Spring Water Stream	B-1	3	40.6	3.69	3..85	1.99	38,200	12,282	1,768,601	1.8543	0.9900	12,159	1,750,911	522.30
04911412	Good Spring Water Stream	B-1	4	58.5	3.73	3.88	1.99	54,390	17,487	2,518,173	1.8744	0.9923	17,352	2,498,707	509.40
04911412	Good Spring Water Stream	B-1	6	77.6	3.68	3.90	1.99	40,470	13,012	1,873,698	1.8492	0.9894	12,875	1,853,928	519.00
04911412	Good Spring Water Stream	B-1	7	92.8	3.72	3.89	1.99	50,640	16,282	2,344,554	1.8693	0.9917	16,146	2,325,071	522.20
04911412	Good Spring Water Stream	B-1	8	114.6	3.71	3.90	1.99	45,750	14,709	2,118,154	1.8643	0.9911	14,579	2,099,341	527.70
04911412	Good Spring Water Stream	B-1	10	133.0	3.72	3.83	1.99	47,150	15,160	2,182,972	1.8693	0.9917	15,034	2,164,832	526.60
04911412	Good Spring Water Stream	B-1	11	148.5	3.70	3.83	1.99	44,340	14,256	2,052,873	1.8593	0.9906	14,121	2,033,482	528.10
04911412	Good Spring Water Stream	B-2	1	13.4	3.72	3.99	1.99	26,500	8,520	1,226,909	1.8693	0.9917	8,449	1,216,713	524.11
04911412	Good Spring Water Stream	B-2	3	43.8	3.73	3.90	1.99	26,430	8,498	1,223,668	1.8744	0.9923	8,432	1,214,209	516.30
04911412	Good Spring Water Stream	B-2	4	57.8	3.76	3.88	1.99	31,420	10,102	1,454,697	1.8894	0.9941	10,042	1,446,053	522.70
04911412	Good Spring Water Stream	B-2	6	83.0	3.74	3.88	1.99	39,690	12,761	1,837,586	1.8794	0.9929	12,670	1,824,460	527.8 Vertical Hairline Fracture in Core
04911412	Good Spring Water Stream	B-2	7	95.3	3.76	3.90	1.99	49,400	15,883	2,287,143	1.8894	0.9941	15,789	2,273,553	532.90
04911412	Good Spring Water Stream	B-2	8	111.1	3.74	3.90	1.99	40,940	13,163	1,895,459	1.8794	0.9929	13,069	1,881,920	529.60
04911412	Good Spring Water Stream	B-2	9	123.2	3.77	3.90	1.99	36,930	11,874	1,709,802	1.8945	0.9947	11,810	1,700,689	529.70



LEGEND:

◎ Geotechnical Soil Boring (SB) Locations

TETRA TECH

GEOTECHNICAL BORING LOCATIONS
HDD S2-0210
CUMBERLAND COUNTY, MIDDLESEX TOWNSHIP, PA
SUNOCO PENNSYLVANIA PIPELINE PROJECT

TETRA TECH
240 Continental Drive, Suite 200
Newark, Delaware 19713
302.738.7551
fax: 302.454.5988

TEST BORING LOG

Project Name:	SUNOCO PENNSYLVANIA PIPELINE PROJECT		Project No.: 103IP3406
Project Location:	PILOT DRIVE, CARLISLE, PA		Page 1 of 1
HDD No.:	S2-0210	Dates(s) Drilled: 01-25-15	Inspector: E. WATT
Boring No.:	SB-01	Drilling Method: SPT - ASTM D1586	Driller: S. HOFFER
Drilling Contractor:	HAD DRILLING	Groundwater Depth (ft): NOT ENCOUNTERED	Total Depth (ft): 15.0

Sample No.	Sample Depth (ft) From	Sample Depth (ft) To	Strata Depth (ft) From	Strata Depth (ft) To	Recov. (in)	Strata (USCS)	Description of Materials	6" Increment Blows *				N
			0.0	0.0			TOPSOIL (<1 ")					
1	3.0	5.0	0.0		15	ML	BROWN TO ORANGE BROWN SILT, TRACE FINE SAND	1	5	4	5	**9**
				7.5			(USCS: ML).					
2	8.0	8.8	7.5	8.8	5		GRAY WEATHERED LIMESTONE?	24	50/3"			**>50**
							AUGER REFUSAL AT 8.5'. OFF-SET BORING 18' NW, AND					
							AUGERED TO BELOW TEST DEPTH.					
3	13.0	15.0			6	MH	GRAY TO LIGHT BROWN SOFT ELASTIC SILT (USCS: MH).	1	1	1	2	**2**
4	15.0	15.0		TRACE			GRAY WEATHERED LIMESTONE?	50/0"				
							AUGER REFUSAL AT 15'. OFF-SET BORING AGAIN AND					
							CONTINUOUSLY AUGERED TO REFUSAL AT 13.8'.					
							REFUSAL MATERIAL MIGHT BE A RESULT OF BOULDERY					
							SUBSURFACE CONDITIONS.					

Notes/Comments:

Pocket Pentrometer Testing
S1: 1.0 TSF
S2: 2.75 TSF

Strata (USCS) Designations are approximated based on visual review, except where indicated in Description of Materials.

* Number of blows of 140 lb. Hammer dropped 30 in. required to drive 2 in. split-spoon sampler in 6 in. increments.
N: Number of blows to drive spoon from 6" to 18" interval.

TETRA TECH
240 Continental Drive, Suite 200
Newark, Delaware 19713
302.738.7551
fax: 302.454.5988

TEST BORING LOG

Project Name:	SUNOCO PENNSYLVANIA PIPELINE PROJECT		Project No.: 103IP3406
Project Location:	S. MIDDLESEX ROAD, NEAR SHOULDER OF I-76 W, CARLISLE, PA		Page 1 of 1
HDD No.:	S2-0210	Dates(s) Drilled: 01-25-15	Inspector: E. WATT
Boring No.:	SB-02	Drilling Method: SPT - ASTM D1586	Driller: S. HOFFER
Drilling Contractor:	HAD DRILLING	Groundwater Depth (ft): 11.0	Total Depth (ft): 30.0

Sample No.	Sample Depth (ft) From	Sample Depth (ft) To	Strata Depth (ft) From	Strata Depth (ft) To	Recov. (in)	Strata (USCS)	Description of Materials	6" Increment Blows *				N
			0.0	0.1			TOPSOIL (1 ")					
1	3.0	5.0	0.1		12	MH	ORANGE BROWN SILT, TRACE TO A LITTLE FINE SAND, WITH A TRACE	2	5	9	8	**14**
							FINE ROCK FRAGMENTS.					
2	8.0	8.8			24		ORANGE BROWN SILT, TRACE FINE SAND, WITH A TRACE	4	3	5	5	**8**
							FINE ROCK FRAGMENTS. (USCS: MH).					
3	13.0	15.0			24		ORANGE BROWN TO YELLOW BROWN ELASTIC SILT, TRACE FINE	1	2	3	10	**5**
							SAND, TRACE FINE ROCK FRAGMENTS (USCS: MH).					
4**	18.0	20.0			2		ORANGE BROWN SILT WITH SOME FINE SAND.	-	-	-	WH	**WH**
5	23.0	25.0			24		VERY SOFT BROWN SILT AND FINE SAND, TRACE LIMESTONE ROCK	1	1	WH	4	**1**
				26.5			FRAGMENTS.					
6	28.0	28.4	26.5	28.4	5		GRAY WEATHERED LIMESTONE MIXED WITH ORANGE BROWN SILT.	50/5"				
							AUGURED TO 30 FEET.					
							**WHEN COLLECTING 18' SAMPLE, RODS SETTLED 18", TO 19.5' BY					
							ROD WEIGHT ALONE. POTENTIAL VOID?					
							GRINDING BETWEEN 15' AND 16'.					
							WATER LEVEL THROUGH AUGERS AT 11'.					
							CAVED AT 10', WATER LEVEL ON CAVE AT 10'.					

Notes/Comments:

<u>Pocket Pentrometer Testing</u>
S1: 2 TSF
S2: 1.75 TSF
S3: 0.75 TSF

Strata (USCS) Designations are approximated based on visual review, except where indicated in Description of Materials.

* Number of blows of 140 lb. Hammer dropped 30 in. required to drive 2 in. split-spoon sampler in 6 in. increments.
N: Number of blows to drive spoon from 6" to 18" interval.

GEOTECHNICAL LABORATORY TESTING SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S2-0210

HDD No.	Test Boring No.	Sample No.	Depth of Sample (ft.) From	Depth of Sample (ft.) To	Water Content, % (ASTM D2216)	Percent Silts/Clays, % (ASTM D1140)	Atterburg Limits (ASTM D4318) Liquid Limit, %	Atterburg Limits (ASTM D4318) Plastic Limit, %	Atterburg Limits (ASTM D4318) Plasticity Index, %	USCS Classif. (ASTM D2487)
S2-0210	SB-01	1	3.0	5.0	23.5	92.4	35	27	8	ML
		3	13.0	15.0	53.5	87.9	55	34	21	MH
	SB-02	1	3.0	5.0	31.6	89.9	-	-	-	-
		2	8.0	8.8	36.2	97.0	54	36	18	MH
		3	13.0	15.0	31.8	92.9	53	31	22	MH
		4	18.0	20.0	38.9	75.9	-	-	-	-
		5	23.0	25.0	26.3	53.1	-	-	-	-
		6	28.0	28.4	11.2	36.1	-	-	-	-

1) Sample depths based on feet below grade at time of exploration.

REGIONAL GEOLOGY SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S2-0210

HDD No.	NAME	BORING NO.	REGIONAL GEOLOGY DESCRIPTION	GENERAL TOPOGRAPHIC SETTING	BEDROCK FORMATION	GENERAL ROCK TYPE	APPROX MAX FM THICKNESS (FT)	DEPTH TO ROCK (Ft bgs) based on nearby well drilling logs	NOTES / COMMENTS
S2-0210	Sunday	SB-01	**St. Paul Group** - consists of buff-colored magnesium limestone and very finely crystalline birdseye limestone at its top and base.	Level terrain	St. Paul Group	Crystalline limestone, chert, and dolomite (St. Paul)	1,500	Highly variable! 2-118, average DTB ~30 ft bgs	Yields: 8-60 gpm
		SB-02							Very finely crystalline, "birdseye" limestone at top and base, granular fossiliferous limestone, black chert, and dolomite in middle

Note : Source of well log data - http://www.dcnr.state.pa.us/topogeo/groundwater/pagwis/records/index.htm. All other sources as referenced in comments section.

FIELD DESCRIPTION AND LOGGING SYSTEM FOR SOIL EXPLORATION

GRANULAR SOILS

(Sand, Gravel & Combinations)

Density	***N (blows)****
Very Loose	5 or less
Loose	6 to 10
Medium Dense	11 to 30
Dense	31to 50
Very Dense	51 or more

Relative Proportions

Description Term	*Percent*
Trace	1 - 10
Little	11 - 20
Some	21 - 35
And	36 - 50

Particle Size Identification

Boulders	8 in. diameter or more	
Cobbles	3 to 8 in. diameter	
Gravel	Coarse (C)	3 in. to ¾ in. sieve
	Fine (F)	¾ in. to No. 4 sieve
Sand	Coarse (C)	No. 4 to No. 10 sieve (4.75mm-2.00mm)
	Medium (M)	No. 10 to No. 40 sieve (2.00mm – 0.425mm)
	Fine (F)	No. 40 to No. 200 sieve (0.425 – 0.074mm)
Silt/Clay	Less Than a No. 200 sieve (<0.074mm)	

COHESIVE SOILS

(Silt, Clay & Combinations)

Consistency	***N (blows)****
Very Soft	3 or less
Soft	4 to 5
Medium Stiff	6 to 10
Stiff	11 to 15
Very Stiff	16 to 30
Hard	31 or more

Plasticity

Degree of Plasticity	*Plasticity Index*
None to Slight	0 - 4
Slight	5 - 7
Medium	8- 22
High to Very High	> 22

ROCK

(Rock Cores)

Rock Quality Designation (RQD), %	***Rock Quality Description***
0-25	Very Poor
25-50	Poor
50-75	Fair
75-90	Good
90-100	Excellent

****N - Standard Penetration Resistance.*** Driving a 2.0" O.D., 1-3/8" I.D. sampler a distance of 18 inches into undisturbed soil with a 140 pound hammer free falling a distance of 30.0 inches. The number of hammer blows to drive the sampler through each 6 inch interval is recorded; the number of blows required to drive the sampler through the final 12 inch interval is termed the Standard Penetration Resistance (SPR) N-value. For example, blow counts of 6/8/9 (through three 6-inch intervals) results in an SPR N-value of 17 (8+9).

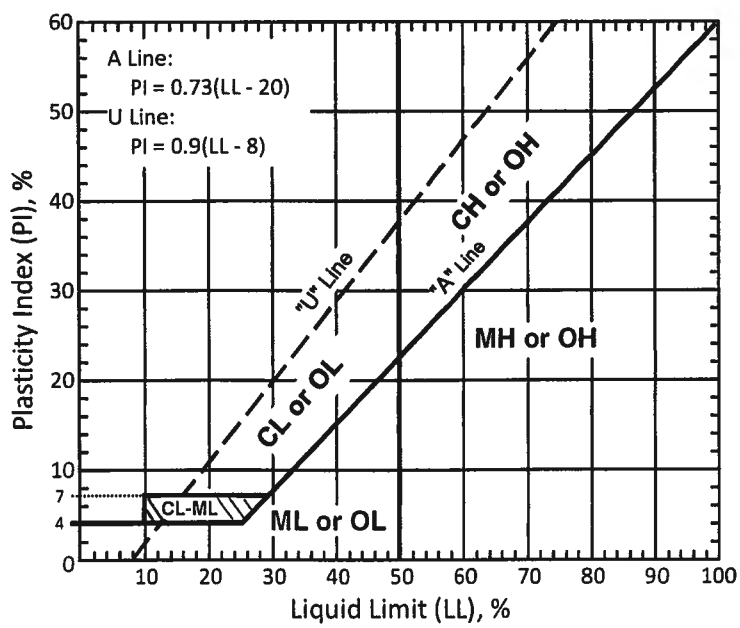
Groundwater observations were made at the times indicated. Groundwater elevations fluctuate throughout a given year, depending on actual field porosity and variations in seasonal and annual precipitation.

UNIFIED SOIL CLASSIFICATION SYSTEM [Casagrande (1948)]

Major Divisions			Group Symbols	Typical Descriptions	Laboratory Classifications		
Coarse Grained Soils (More than half of material is larger than No. 200 sieve)	Gravels More than half of coarse fraction is larger than No. 4 sieve size	Clean gravel (Little or no fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines	Determine Percentage of sand and gravel from grain size curve. Depending on Percentage of fines (fraction smaller than No. 200 sieve), coarse-grained soils are classified as follows: Less than 5 percent GW, GP, SW, SP; More than 12 percent GM, GC, SM, SC; 5 to 12 percent Borderline cases requiring dual symbols(1)	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4: $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines		Not meeting C_u or C_c requirements for GW	
		Gravel with fines (Appreciable amount of fines)	GM	Silty gravels, gravel-sand-silt mixtures		Atterberg limits below A Line or I_p less than 4	Limits plotting in hatched zone with I_p between 4 and 7 are borderline cases requiring use of dual symbols
			GC	Clayey gravels, gravel-sand-clay mixtures		Atterberg limits above A line with I_p greater than 7	
	Sands (More than half of coarse fraction is smaller than No. 4 Sieve)	Clean sands (Little or no fines)	SW	Well graded sands, gravely sands, little or no fines		$C_u = \frac{D_{60}}{D_{10}}$ greater than 6 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
			SP	Poorly graded sands, gravelly sands, little or no fines		Not meeting C_u or C_c requirements for SW	
		Sands with fines (Appreciable amount of fines)	SM	Silty sands, sand-silt mixtures		Atterberg limits below A Line or I_p less than 4	Limits Plotting in hatched zone with I_p between 4 and 7 are borderline cases requiring use of dual symbols
			SC	Clayey sands, sand-clay mixtures		Atterberg limits above A line with I_p greater than 7	

Major Divisions		Group Symbols	Typical Descriptions
Fine-grained soils (More than half of material is smaller than No. 200 sieve)	Silts and clays (Liquid limit less than 50)	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
		OL	Organic silts and organic silty clays of low plasticity
	Silts and Clays (Liquid limit greater than 50)	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
		CH	Inorganic clays of high plasticity, fat clays
		OH	Organic clays of medium to high plasticity, organic silts
	Highly organic soils	Pt	Peat and other highly organic soils

For soils plotting nearly on A line use dual symbols i.e., I_p = 29.5, w_L=60 gives CH-MH. When w_L is near 50 use CL-CH or ML-MH. Take near as ± 2 percent.



(1) Borderline classifications, used for soils possessing characteristics of two groups, are designated by combinations of group symbols. For example: GW-GC. well-graded gravel-sand mixture with clay binder.

RETTEW

ATTACHMENT 2
SOIL RESOURCES MAP AND PROFILE DESCRIPTIONS

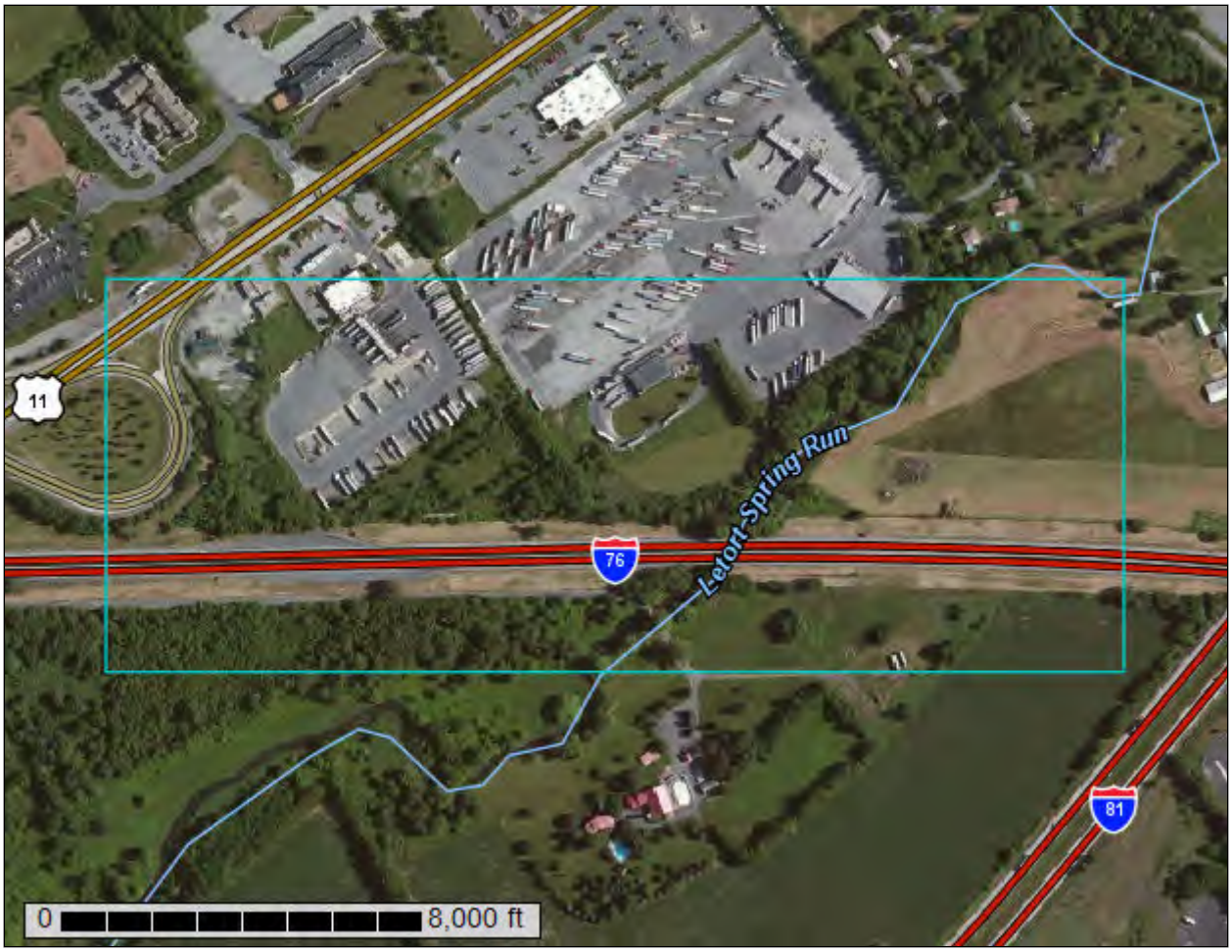
United States Department of Agriculture

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Cumberland County, Pennsylvania

LeTort Spring Run HDD



January 9, 2018

Custom Soil Resource Report
Soil Map

Map Scale: 1:4,810 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 50 100 200 300

Feet: 0 200 400 800 1200

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Unit Polygons

Soil Map Unit Lines

Soil Map Unit Points

Special Point Features

Blowout

Borrow Pit

Clay Spot

Closed Depression

Gravel Pit

Gravelly Spot

Landfill

Lava Flow

Marsh or swamp

Mine or Quarry

Miscellaneous Water

Perennial Water

Rock Outcrop

Saline Spot

Sandy Spot

Severely Eroded Spot

Sinkhole

Slide or Slip

Sodic Spot

Spoil Area

Stony Spot

Very Stony Spot

Wet Spot

Other

Special Line Features

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Cumberland County, Pennsylvania
Survey Area Data: Version 11, Nov 27, 2017

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jun 18, 2010—Sep 25, 2010

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
BeB	Berks channery silt loam, 3 to 8 percent slopes	2.7	3.8%
HaA	Hagerstown silt loam, 0 to 3 percent slopes	35.1	48.0%
HaB	Hagerstown silt loam, 3 to 8 percent slopes	10.3	14.1%
HaC	Hagerstown silt loam, 8 to 15 percent slopes	0.7	1.0%
HcB	Hagerstown silt loam, rocky, 3 to 8 percent slopes	10.5	14.3%
Ub	Urban land and Udorthents	2.5	3.5%
Wa	Warners silt loam	11.2	15.4%
Totals for Area of Interest		**73.2**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not

mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Cumberland County, Pennsylvania

BeB—Berks channery silt loam, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 2sgb5
Elevation: 320 to 3,570 feet
Mean annual precipitation: 37 to 50 inches
Mean annual air temperature: 47 to 56 degrees F
Frost-free period: 148 to 192 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Berks and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Berks

Setting

Landform: Ridges, mountain slopes
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Upper third of mountainflank, side slope
Down-slope shape: Convex
Across-slope shape: Convex, linear
Parent material: Residuum weathered from shale and siltstone and/or fine grained sandstone

Typical profile

Ap - 0 to 7 inches: channery silt loam
Bw1 - 7 to 15 inches: channery silt loam
Bw2 - 15 to 28 inches: very channery silt loam
C - 28 to 36 inches: extremely channery silt loam
R - 36 to 46 inches: bedrock

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: 20 to 40 inches to lithic bedrock
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.06 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 1 percent
Gypsum, maximum in profile: 1 percent
Salinity, maximum in profile: Nonsaline (0.0 to 1.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 1.0
Available water storage in profile: Very low (about 2.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: B

Other vegetative classification: Dry Uplands (DU2)
Hydric soil rating: No

Minor Components

Weikert

Percent of map unit: 10 percent
Landform: Ridges
Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Convex
Other vegetative classification: Droughty Shales (SD2)
Hydric soil rating: No

Brinkerton

Percent of map unit: 5 percent
Landform: Ridges
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave, linear
Across-slope shape: Linear, concave
Hydric soil rating: Yes

HaA—Hagerstown silt loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 2tb05
Elevation: 310 to 1,750 feet
Mean annual precipitation: 37 to 45 inches
Mean annual air temperature: 45 to 57 degrees F
Frost-free period: 155 to 205 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Hagerstown and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Hagerstown

Setting

Landform: Hills
Landform position (two-dimensional): Backslope, footslope, summit
Landform position (three-dimensional): Side slope, interfluve
Down-slope shape: Linear, concave
Across-slope shape: Linear, concave
Parent material: Clayey residuum weathered from limestone

Typical profile

Ap - 0 to 10 inches: silt loam

Bt1 - 10 to 21 inches: silty clay loam
Bt2 - 21 to 56 inches: silty clay
C - 56 to 73 inches: silty clay loam
R - 73 to 83 inches: bedrock

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: 43 to 98 inches to lithic bedrock
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline (0.0 to 1.9 mmhos/cm)
Available water storage in profile: Moderate (about 7.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 1
Hydrologic Soil Group: B
Hydric soil rating: No

Minor Components

Opequon

Percent of map unit: 5 percent
Landform: Ridges
Landform position (two-dimensional): Shoulder, summit
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Linear, convex
Across-slope shape: Convex, linear
Hydric soil rating: No

Carbo

Percent of map unit: 5 percent
Landform: Hills
Landform position (two-dimensional): Summit, backslope, shoulder
Landform position (three-dimensional): Crest, side slope
Down-slope shape: Linear, convex
Across-slope shape: Linear, convex
Hydric soil rating: No

Nolin

Percent of map unit: 3 percent
Landform: Swales
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope, talf
Down-slope shape: Linear, concave
Across-slope shape: Linear, concave
Hydric soil rating: No

Funkstown

Percent of map unit: 2 percent
Landform: Valley floors
Landform position (two-dimensional): Toeslope

Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Concave, linear
Hydric soil rating: No

HaB—Hagerstown silt loam, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 2rc98
Elevation: 600 to 1,750 feet
Mean annual precipitation: 37 to 45 inches
Mean annual air temperature: 45 to 55 degrees F
Frost-free period: 155 to 190 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Hagerstown and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Hagerstown

Setting

Landform: Hills
Landform position (two-dimensional): Backslope, footslope, summit
Landform position (three-dimensional): Side slope, base slope, interfluve
Down-slope shape: Linear, concave
Across-slope shape: Linear, concave
Parent material: Clayey residuum weathered from limestone

Typical profile

Ap - 0 to 10 inches: silt loam
Bt1 - 10 to 21 inches: silty clay loam
Bt2 - 21 to 56 inches: silty clay
C - 56 to 73 inches: silty clay loam
R - 73 to 83 inches: bedrock

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: 43 to 98 inches to lithic bedrock
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: B
Hydric soil rating: No

Minor Components

Opequon

Percent of map unit: 5 percent
Landform: Ridges
Landform position (two-dimensional): Shoulder, summit
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Linear, convex
Across-slope shape: Convex, linear
Hydric soil rating: No

Carbo

Percent of map unit: 5 percent
Landform: Hills
Landform position (two-dimensional): Summit, backslope, shoulder
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Linear, convex
Across-slope shape: Linear, convex
Hydric soil rating: No

Funkstown

Percent of map unit: 3 percent
Landform: Valley floors
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Concave, linear
Hydric soil rating: No

Timberville

Percent of map unit: 2 percent
Landform: Hills
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Head slope, base slope
Down-slope shape: Concave, linear
Across-slope shape: Convex, concave, linear
Hydric soil rating: No

HaC—Hagerstown silt loam, 8 to 15 percent slopes

Map Unit Setting

National map unit symbol: 2tb03
Elevation: 600 to 1,750 feet
Mean annual precipitation: 32 to 45 inches
Mean annual air temperature: 41 to 65 degrees F
Frost-free period: 155 to 181 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Hagerstown and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Hagerstown

Setting

Landform: Hillslopes
Landform position (two-dimensional): Backslope, shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Linear, convex, concave
Across-slope shape: Linear, convex
Parent material: Clayey residuum weathered from limestone and dolomite

Typical profile

Ap - 0 to 8 inches: silt loam
Bt1 - 8 to 19 inches: silty clay loam
Bt2 - 19 to 54 inches: silty clay
C - 54 to 71 inches: silty clay loam
R - 71 to 81 inches: bedrock

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: 43 to 98 inches to lithic bedrock
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline (0.0 to 1.9 mmhos/cm)
Available water storage in profile: Moderate (about 7.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B
Hydric soil rating: No

Minor Components

Carbo

Percent of map unit: 8 percent
Landform: Hills
Landform position (two-dimensional): Summit, backslope, shoulder
Landform position (three-dimensional): Crest, side slope
Down-slope shape: Linear, convex
Across-slope shape: Linear, convex
Hydric soil rating: No

Opequon

Percent of map unit: 5 percent
Landform: Ridges
Landform position (two-dimensional): Shoulder, summit

Landform position (three-dimensional): Side slope, crest
Down-slope shape: Linear, convex
Across-slope shape: Convex, linear
Hydric soil rating: No

Clarksburg

Percent of map unit: 2 percent
Landform: Hillslopes
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope, head slope
Down-slope shape: Linear
Across-slope shape: Concave
Hydric soil rating: No

HcB—Hagerstown silt loam, rocky, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: r8wn
Elevation: 460 to 1,500 feet
Mean annual precipitation: 30 to 45 inches
Mean annual air temperature: 45 to 57 degrees F
Frost-free period: 140 to 200 days
Farmland classification: Not prime farmland

Map Unit Composition

Hagerstown and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Hagerstown

Setting

Landform: Ridges
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Clayey residuum weathered from argillaceous limestone

Typical profile

H1 - 0 to 10 inches: silt loam
H2 - 10 to 19 inches: clay
H3 - 19 to 57 inches: clay

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: 40 to 84 inches to lithic bedrock
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches

Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: High (about 10.0 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2s
Hydrologic Soil Group: B
Hydric soil rating: No

Ub—Urban land and Udorthents

Map Unit Setting
National map unit symbol: r8yg
Mean annual precipitation: 36 to 50 inches
Mean annual air temperature: 46 to 59 degrees F
Frost-free period: 120 to 215 days
Farmland classification: Not prime farmland

Map Unit Composition
Urban land: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Urban Land

Setting
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Pavement, buildings and other artifically covered areas

Properties and qualities
Slope: 0 to 8 percent
Depth to restrictive feature: 10 inches to densic material
Runoff class: Very high

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8s
Hydric soil rating: No

Minor Components

Udorthents, steep
Percent of map unit: 10 percent
Landform: Mountains
Landform position (two-dimensional): Summit, backslope
Landform position (three-dimensional): Mountaintop
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Wa—Warners silt loam

Map Unit Setting

National map unit symbol: r8yj
Elevation: 250 to 1,000 feet
Mean annual precipitation: 30 to 45 inches
Mean annual air temperature: 46 to 55 degrees F
Frost-free period: 140 to 210 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Warners and similar soils: 90 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Warners

Setting

Landform: Depressions
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear, concave
Across-slope shape: Linear, concave
Parent material: Carbonatic fine-silty alluvium

Typical profile

H1 - 0 to 12 inches: silt loam
H2 - 12 to 33 inches: silt loam
H3 - 33 to 62 inches: marl

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Very poorly drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 2.00 in/hr)
Depth to water table: About 0 inches
Frequency of flooding: Frequent
Frequency of ponding: Frequent
Calcium carbonate, maximum in profile: 90 percent
Available water storage in profile: High (about 11.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3w
Hydrologic Soil Group: B/D
Hydric soil rating: Yes

Minor Components

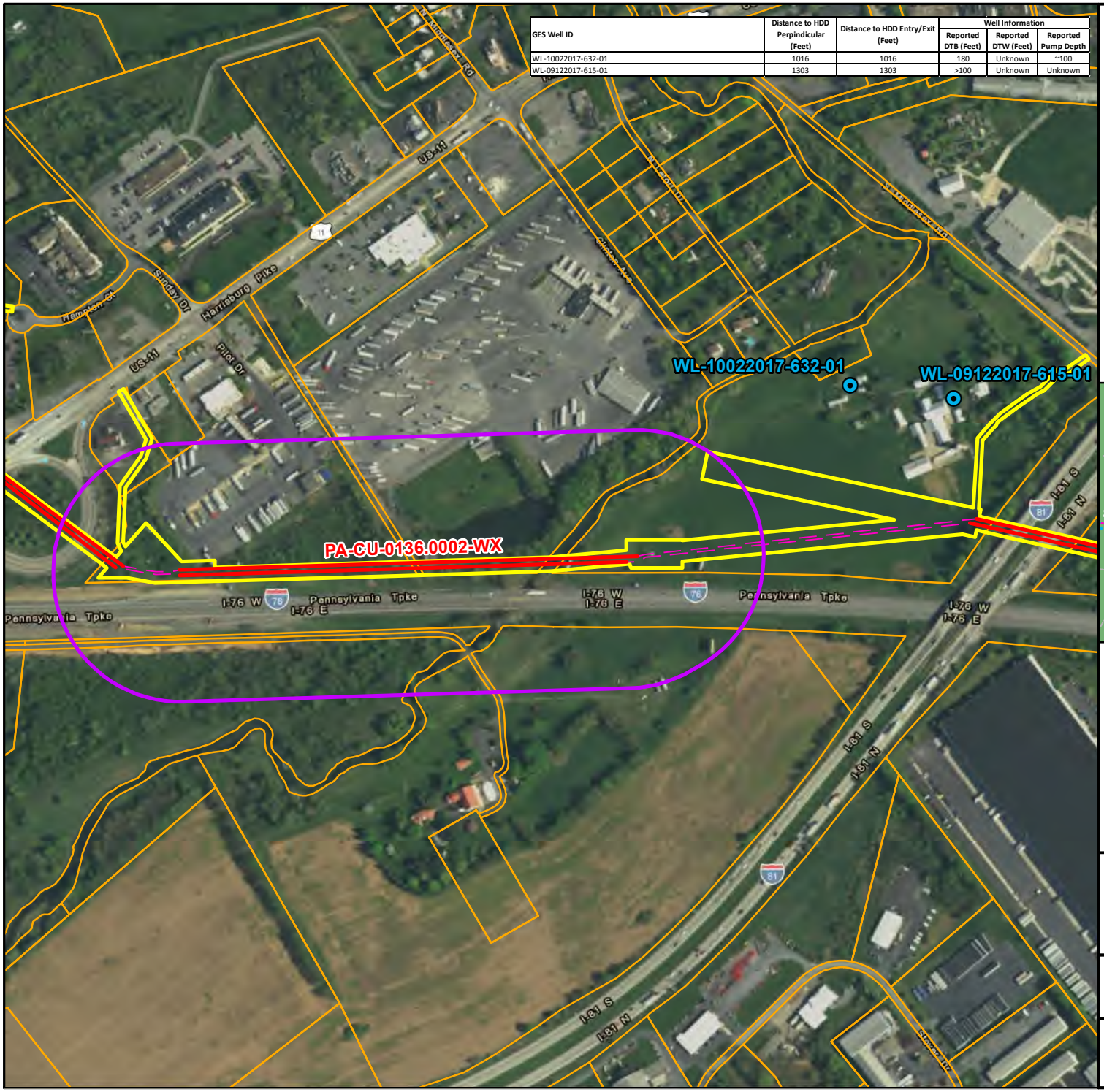
Somewhat poorly drained soils

Percent of map unit: 5 percent
Hydric soil rating: No

RETTEW

ATTACHMENT 3
450-FOOT WELL SURVEY

GES Well ID	Distance to HDD Perpindicular (Feet)	Distance to HDD Entry/Exit (Feet)	Well Information		
			Reported DTB (Feet)	Reported DTW (Feet)	Reported Pump Depth
WL-10022017-632-01	1016	1016	180	Unknown	~100
WL-09122017-615-01	1303	1303	>100	Unknown	Unknown



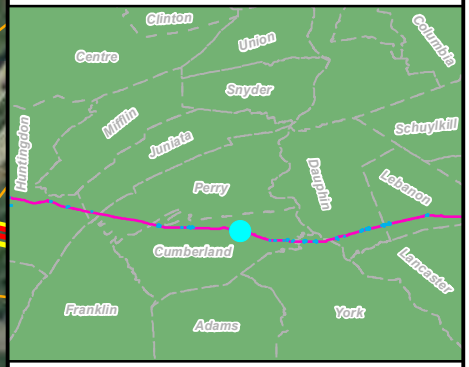
Legend

- LOD
- Parcel
- PPP Centerline
- HDD
- 450 foot buffer of HDD alignment

****Testing locations current as of 11/27/2017**

- GES Testing Location

Location



0 250 500 Feet

Well Location Map
HDD# PA-CU-0136.0002-WX
Cumberland County, PA.

Prepared By:

Date: 11/29/2017

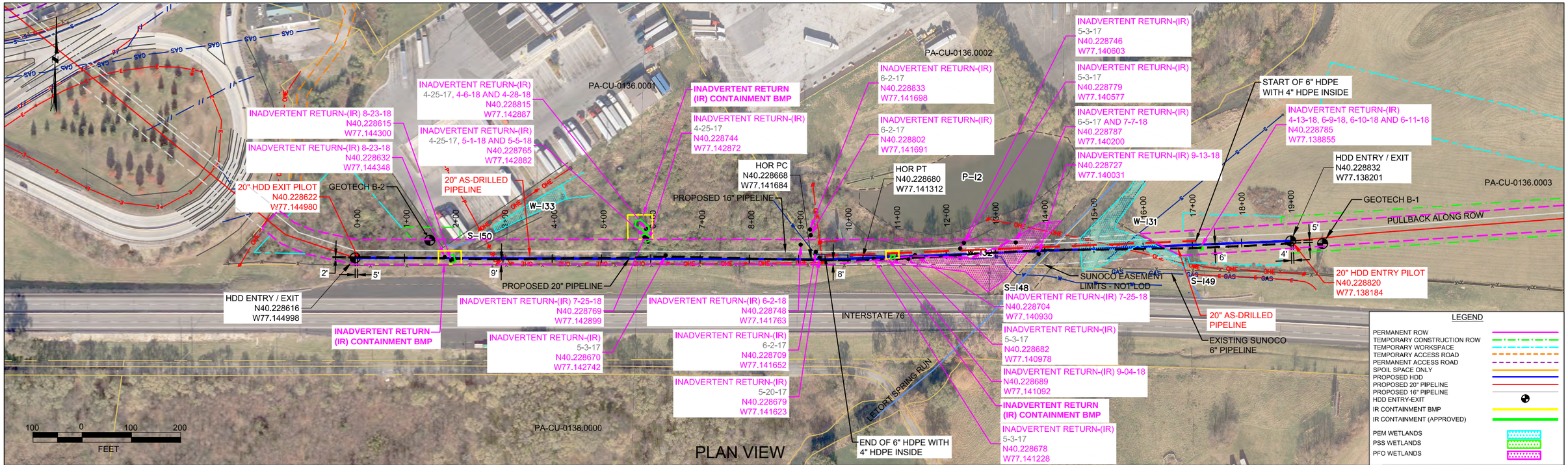
Base Map;
ESRI World Imagery, 09/24/2015

Coordinate System: NAD 83 Stateplane, PA South, Feet

P:\GIS\projects\112\03938-PPP\MXD\WellLocations\WellLocation_PA_CU_0136_0002.mxd JL

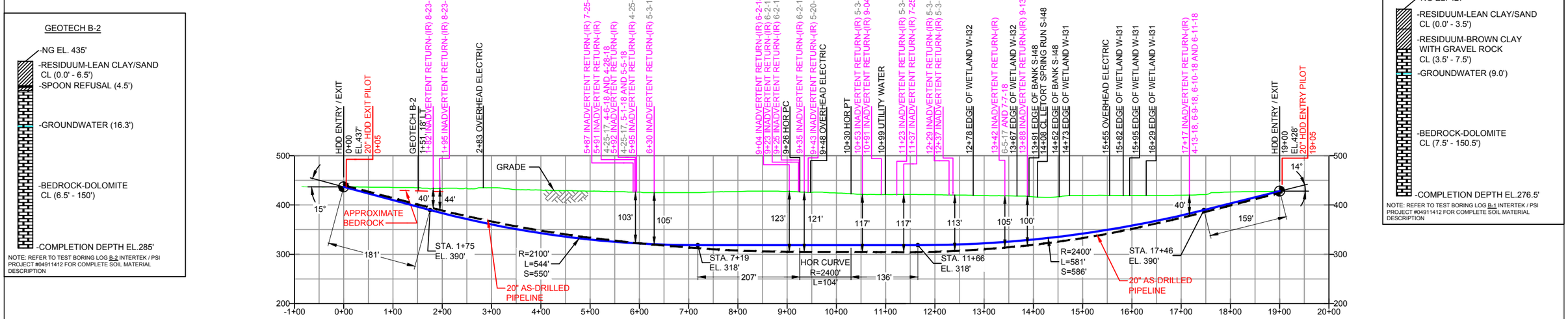
ATTACHMENT 2

2017 AND 2018 16-INCH HORIZONTAL DIRECTIONAL DRILL PLAN AND PROFILES



CUMBERLAND COUNTY, PENNSYLVANIA - MIDDLESEX TOWNSHIP
S2-0210

PROFILE VIEW



DESIGN AND CONSTRUCTION:

1. CONTRACTOR SHALL FIELD VERIFY DEPTH OF ALL EXISTING UTILITIES SHOWN OR NOT SHOWN ON THIS DRAWING.
2. THE MINIMUM SEPARATION DISTANCE FROM EXISTING SUBSURFACE UTILITIES SHALL NOT BE LESS THAN 10 FEET AS MEASURED FROM THE OUTSIDE EDGE OF THE UTILITY TO OUTSIDE OF PROPOSED PIPELINE.
3. DESIGNED IN ACCORDANCE WITH CFR 49 195 & ASME B31.4
4. CROSSING PIPE SPECIFICATION:
   HDD HORZ. LENGTH (L=): 1900'
   HDD PIPE LENGTH (S=): 1921'
   20" x 0.456" W.T., X-65, APISL, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 40 MILS MIN. ARO (POWERCRETE R95)
5. INTERNAL DESIGN PRESSURE 1480 PSIG (SEAM FACTOR 1.0, DESIGN FACTOR 0.50 (HOOP STRESS)).
6. INSTALLATION METHOD: HORIZONTAL DIRECTIONAL DRILL (HDD).
7. PIPELINE WARNING MARKERS SHALL BE INSTALLED ON BOTH SIDES OF ALL ROAD, RAILWAY, AND STREAM CROSSINGS.
8. CARRIER PIPE NOT ENCASED.
9. PIPE / AMBIENT TEMPERATURE MUST BE NO LESS THAN 30°F DURING PULLBACK WITHOUT PRIOR WRITTEN APPROVAL FROM THE ENGINEER.
10. CONDUCT 4-HOUR PRE-INSTALLATION HYDROTEST OF HDD PIPE STRING TO MINIMUM 1850 PSIG.
11. SEE SUNOCO PENNSYLVANIA PIPELINE PROJECT ESRI WEBMAP FOR ACCESS ROAD ALIGNMENT.
12. SUNOCO PIPELINE, L.P.'S HORIZONTAL DIRECTIONAL DRILL INADVERTENT RETURN CONTINGENCY PLAN WILL BE IMPLEMENTED AT ALL TIMES.
13. SUNOCO PIPELINE, L.P.'S EROSION AND SEDIMENTATION CONTROL PLAN WILL BE IMPLEMENTED AT ALL TIMES.
14. CONTRACTOR SHALL CONTINUOUSLY MONITOR THE ANNULAR PRESSURE INSIDE THE PILOT HOLE USING A DOWNHOLE PRESSURE RECORDER DURING THE PILOT PHASE OF THE DRILL AND HE SHALL ACT ON THAT INFORMATION TO FURTHER REDUCE THE LIKELIHOOD OF INADVERTENT RETURNS.

HDD IR OVERLAY

Figure 1. 2017 16-Inch HDD Plan and Profile with 20-Inch IR Data

NOTES

1. ALL COORDINATES SHOWN ARE IN LATITUDE AND LONGITUDE. ALL MSL ELEVATIONS ARE NAD83
2. STATIONING IS BASED ON HORIZONTAL DISTANCES.
3. ROONEY ENGINEERING, INC. AND SUNOCO PIPELINE, LP ARE NOT RESPONSIBLE FOR LOCATION OF FOREIGN UTILITIES SHOWN IN PLOT PLAN OR PROFILE. THE INFORMATION SHOWN HEREON IS FURNISHED WITHOUT LIABILITY ON THE PART OF ROONEY ENGINEERING, INC. AND SUNOCO PIPELINE, LP, FOR ANY DAMAGES RESULTING FROM ERRORS OR OMISSIONS THEREIN.
4. CONTRACTOR IS RESPONSIBLE FOR LOCATING ALL UTILITIES. CONTACT ONE CALL AT 811 PRIOR TO DIGGING.
5. SUNOCO EMERGENCY HOTLINE NUMBER IS #1-800-786-7440.

REF. DRAWING

DWG NO		DWG NO	DESCRIPTION
ES-4.57	TO	ES-4.58	EROSION & SEDIMENT PLAN
SHEET 36	TO	SHEET 37	AERIAL SITE PLAN

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP11	ADDED ADDITIONAL IR INFORMATION (9-13-18)	MRS	09/13/18	RMB	09/13/18	AMC	09/13/18
EP10	ADDED ADDITIONAL IR INFORMATION (9-04-18)	MRS	09/05/18	RMB	09/05/18	AMC	09/05/18
EP9	ADDED ADDITIONAL IR AND AS-DRILLED INFORMATION	MRS	08/31/18	RMB	08/31/18	AMC	08/31/18
EP8	UPDATED AS-DRILLED INFORMATION	MRS	08/23/18	RMB	08/23/18	AMC	08/23/18
EP7	ADDED 6" POLY PIPE AND AS-DRILLED INFORMATION	MRS	08/13/18	RMB	08/13/18	AMC	08/13/18
EP6	ADDED ADDITIONAL IR AND AS-DRILLED INFORMATION	MRS	07/26/18	RMB	07/26/18	AMC	07/26/18

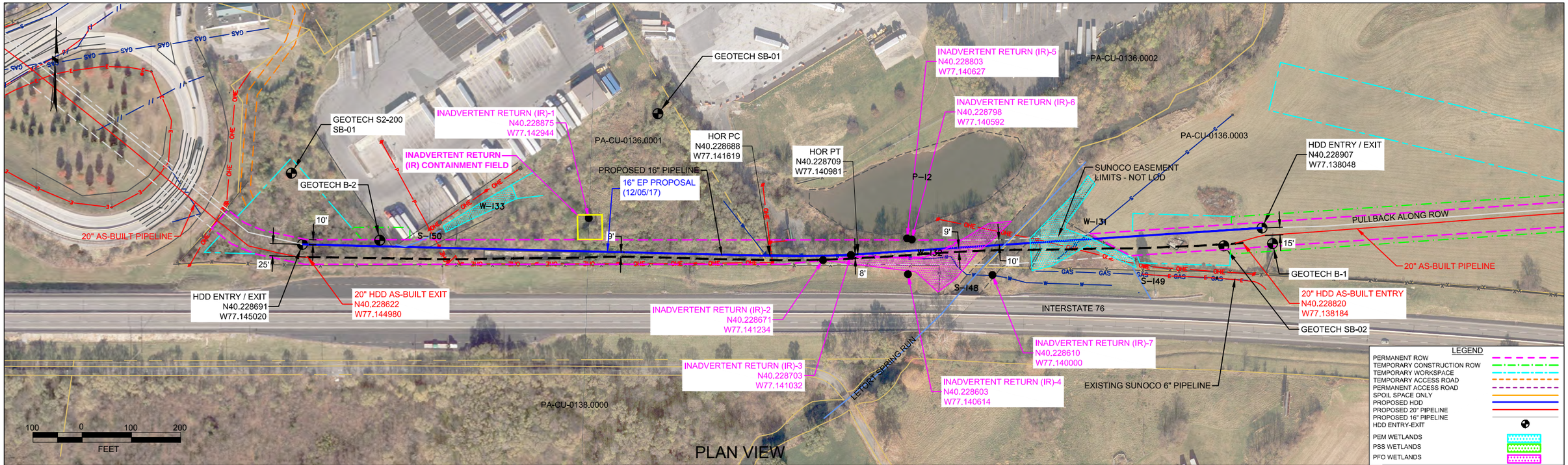
Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

HORIZONTAL DIRECTIONAL DRILL
LETORT SPRING RUN
PENNSYLVANIA PIPELINE PROJECT

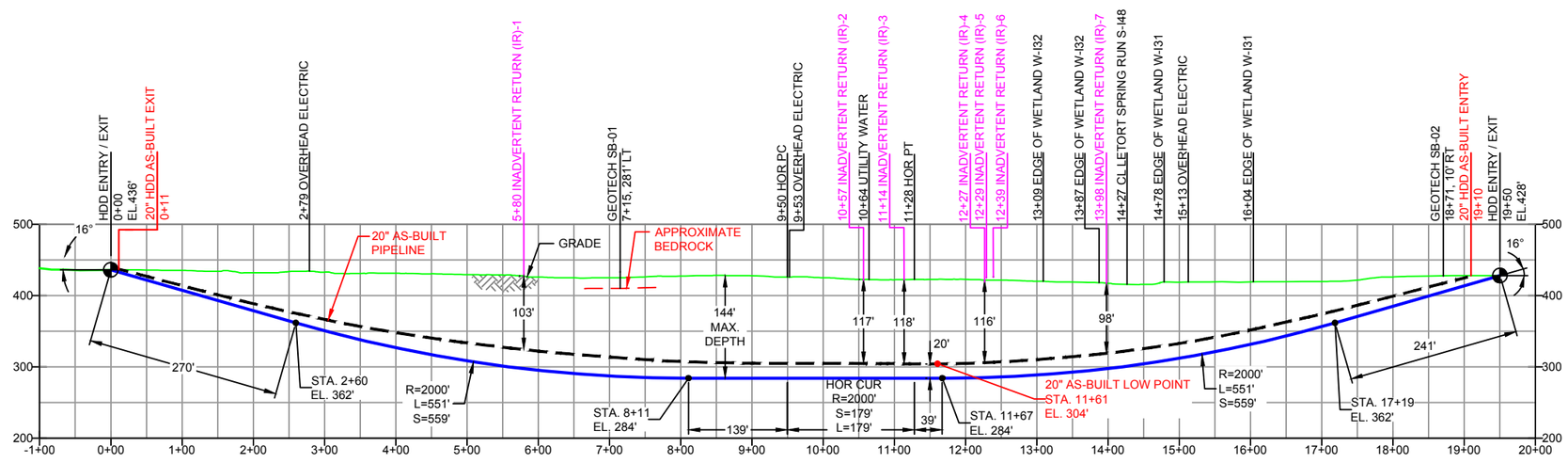
SCALE: 1"=200' DWG. NUMBER: PA-CU-0136.0002-WX



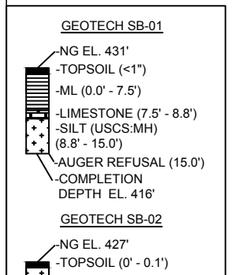
PLAN VIEW

CUMBERLAND COUNTY, PENNSYLVANIA - MIDDLESEX TOWNSHIP
S2-0210-16

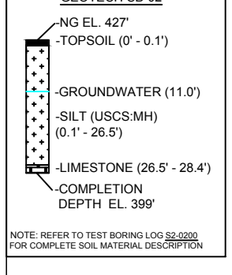
PROFILE VIEW



GEOTECH SB-01

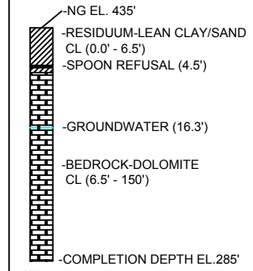


GEOTECH SB-02



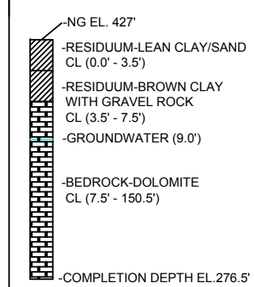
NOTE: REFER TO TEST BORING LOG S2-0200 FOR COMPLETE SOIL MATERIAL DESCRIPTION

GEOTECH B-2



NOTE: REFER TO TEST BORING LOG B-2 INTERTEK / PSI PROJECT #04911412 FOR COMPLETE SOIL MATERIAL DESCRIPTION

GEOTECH B-1



NOTE: REFER TO TEST BORING LOG B-1 INTERTEK / PSI PROJECT #04911412 FOR COMPLETE SOIL MATERIAL DESCRIPTION

DESIGN AND CONSTRUCTION:

1. CONTRACTOR SHALL FIELD VERIFY DEPTH OF ALL EXISTING UTILITIES SHOWN OR NOT SHOWN ON THIS DRAWING.
2. THE MINIMUM SEPARATION DISTANCE FROM EXISTING SUBSURFACE UTILITIES SHALL NOT BE LESS THAN 10 FEET AS MEASURED FROM THE OUTSIDE EDGE OF THE UTILITY TO OUTSIDE OF PROPOSED PIPELINE.
3. DESIGNED IN ACCORDANCE WITH CFR 49 195 & ASME B31.4
4. CROSSING PIPE SPECIFICATION:
   HDD HORZ. LENGTH (L=): 1950'
   HDD PIPE LENGTH (S=): 1986'
   16" x 0.438" W.T., X-70, API5L, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 40 MILS MIN. ARO (POWERCRETE R95)
5. INTERNAL DESIGN PRESSURE 2100 PSIG (SEAM FACTOR 1.0, DESIGN FACTOR 0.50 (HOOP STRESS)).
6. INSTALLATION METHOD: HORIZONTAL DIRECTIONAL DRILL (HDD).
7. PIPELINE WARNING MARKERS SHALL BE INSTALLED ON BOTH SIDES OF ALL ROAD, RAILWAY, AND STREAM CROSSINGS.
8. CARRIER PIPE NOT ENCASED.
9. PIPE / AMBIENT TEMPERATURE MUST BE NO LESS THAN 30°F DURING PULLBACK WITHOUT PRIOR WRITTEN APPROVAL FROM THE ENGINEER.
10. CONDUCT 4-HOUR PRE-INSTALLATION HYDROTEST OF HDD PIPE STRING TO MINIMUM 2625 PSIG.
11. SEE SUNOCO PENNSYLVANIA PIPELINE PROJECT ESRI WEBMAP FOR ACCESS ROAD ALIGNMENT.
12. SUNOCO PIPELINE, L.P.'S HORIZONTAL DIRECTIONAL DRILL INADVERTENT RETURN CONTINGENCY PLAN WILL BE IMPLEMENTED AT ALL TIMES.
13. SUNOCO PIPELINE, L.P.'S EROSION AND SEDIMENTATION CONTROL PLAN WILL BE IMPLEMENTED AT ALL TIMES.

Figure 2. 2018 Redesigned 16-Inch HDD Plan and Profile

NOTES

1. ALL COORDINATES SHOWN ARE IN LATITUDE AND LONGITUDE. ALL MSL ELEVATIONS ARE NAD83
2. STATIONING IS BASED ON HORIZONTAL DISTANCES.
3. ROONEY ENGINEERING, INC. AND SUNOCO PIPELINE, LP ARE NOT RESPONSIBLE FOR LOCATION OF FOREIGN UTILITIES SHOWN IN PLOT PLAN OR PROFILE. THE INFORMATION SHOWN HEREON IS FURNISHED WITHOUT LIABILITY ON THE PART OF ROONEY ENGINEERING, INC. AND SUNOCO PIPELINE, LP. FOR ANY DAMAGES RESULTING FROM ERRORS OR OMISSIONS THEREIN.
4. CONTRACTOR IS RESPONSIBLE FOR LOCATING ALL UTILITIES. CONTACT ONE CALL AT 811 PRIOR TO DIGGING.
5. SUNOCO EMERGENCY HOTLINE NUMBER IS #1-800-786-7440.

REF. DRAWING

DWG NO		DWG NO	DESCRIPTION
ES-4.57	TO	ES-4.58	EROSION & SEDIMENT PLAN
SHEET 36	TO	SHEET 37	AERIAL SITE PLAN

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP5	DESIGN CHANGE - INCREASED DEPTH OF DRILL	MRS	12/11/18	RMB	12/11/18	AMC	12/11/18
EP4	UPDATED NOTE 5 AND 10 PER INCREASED 16" MOP	MRS	04/10/18	RMB	04/10/18	CAG	04/10/18
EP3	LOWERED DRILL AND RELOCATED ENTRY/EXIT - DESIGN CHANGE REQUESTED BY CLIENT	MRS	12/05/17	RMB	12/05/17	CAG	12/05/17
EP2	REVISED PER PADEP COMMENTS RECEIVED 09-06-16	MRS	10/07/16	RMB	10/07/16	AAW	10/07/16
EP1	REVISED PER PADEP COMMENTS	MRS	05/10/16	RMB	05/10/16	AAW	05/10/16
EP		JTW	03/23/16	RMB	03/23/16	AAW	03/23/16

Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

HORIZONTAL DIRECTIONAL DRILL
LETORT SPRING RUN
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=200' | DWG. NO: PA-CU-0136.0002-WX-16